Report

of the

Upper Elbow River

Instream Objectives Working Group

October, 1999

Report of the Upper Elbow River Instream Objectives Working Group

Purpose: The Working Group was created by Alberta Environment to draft recommendations on instream objectives for the upper Elbow River (upstream of Glenmore Reservoir, Figure 2). The terms of reference for the Working Group are provided in Appendix A. The members of the Working Group are listed in Figure 1.

Instream objectives are designed to protect and sustain the aquatic and riparian environments and water for human use. Instream objectives are needed for the upper Elbow River to aid in evaluating and managing development in the basin. The instream objectives for the upper Elbow River will become part of a water management plan for the Bow River Basin.

Figure 1
Members of the Upper Elbow River Instream Objectives Working Group

Frits Bakker
Townsite Manager
Townsite of Redwood Meadows

Tim Belliveau
President, Westridge Water Supply Ltd.

Don Cockerton
Protected Areas Planner, Bow Region
Alberta Environment

Sandra Foss
Member, Calgary Area Outdoor Council

Wayne Fullerton (replaced Gloria Wilkinson)
Councillor, Municipal District of Rocky View

Mike Hawes
Rancher

Laurie Kimber
Municipal Planner
Municipal District of Rocky View

Kit Lewis
Springbank Resident
Member, Bragg Creek Environmental Coalition
Director, Bow River Basin Water Quality Foundation

Bob McIntosh
Environmental Scientist
Sewer Division
Engineering and Environmental Services
City of Calgary

Bob Morrison
Water Planner, Bow Region
Alberta Environment

Gary Munro
Rancher

Jane Pearson
Resident, Townsite of Redwood Meadows
Member, Bragg Creek Environmental Coalition

Jim Rouse
Director, Bow River Chapter, Trout Unlimited Canada
Member, Bow River Basin Water Council

Read Seidner
Laboratory Superintendent
Waterworks Division
Engineering and Environmental Services
City of Calgary

Tony Starlight
Councillor, Tsuu T'ina Nation

Trevor Stauffer
Member, Bragg Creek Environmental Coalition
Member, Bow River Basin Water Council
Director, Bow River Basin Water Quality Foundation

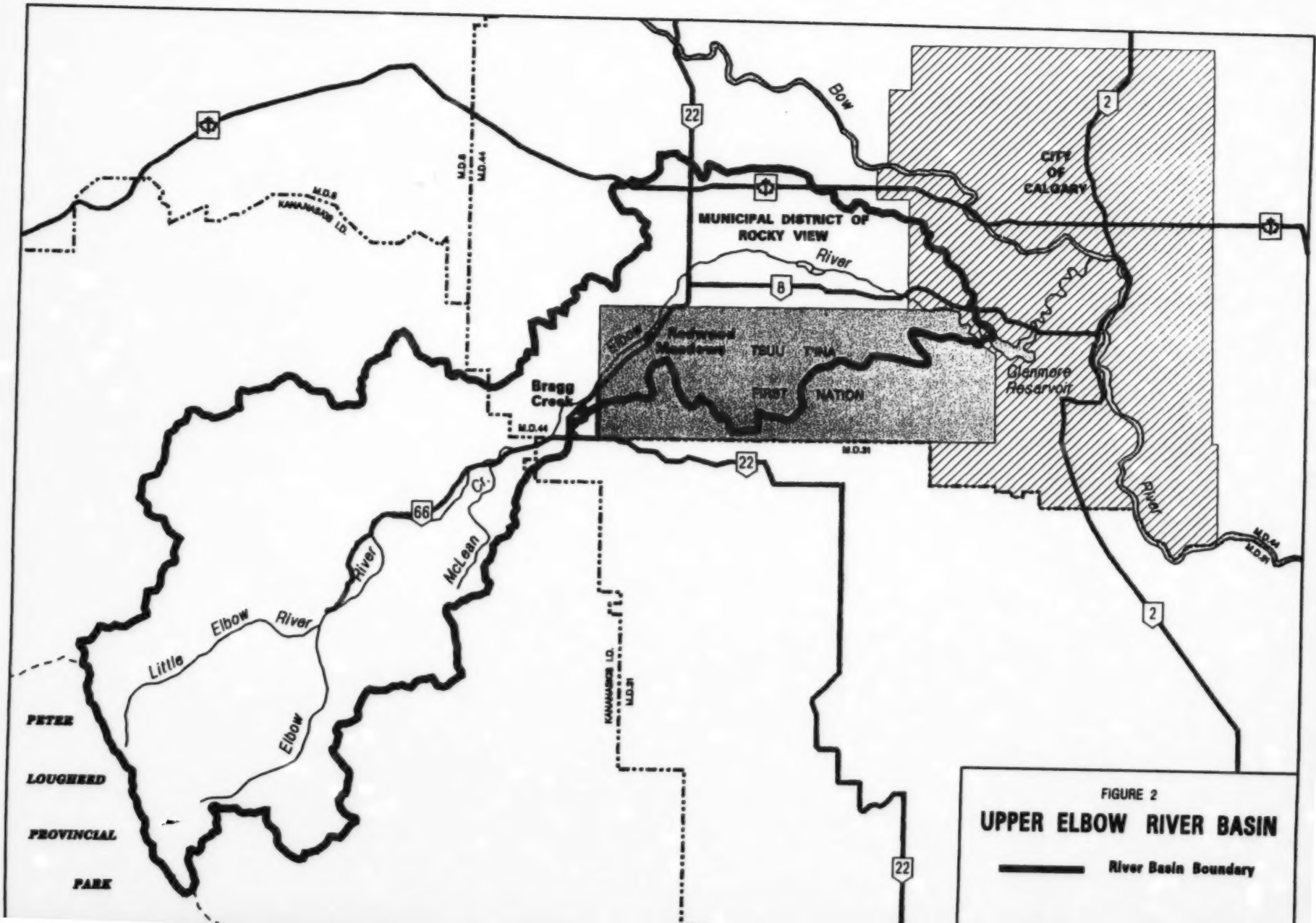
Bow
River
22
2
CITY OF CALGARY
MUNICIPAL DISTRICT OF ROCKY VIEW
8
Elbow River
TSUU T'INA FIRST NATION
Glenmore Reservoir
Bragg Creek
M.D.44
M.D.8
M.D.31
66
Ct.
McLean
River
Elbow River
Little Elbow River
Elbow
PETER LOUGHEED PROVINCIAL PARK
KANANASKIS I.D.
FIGURE 2
UPPER ELBOW RIVER BASIN
River Basin Boundary

Figure 3
Information Considered by the Upper Elbow River Instream Objectives Working Group

- *Elbow River Water Quality Task Force Report*
- *Water Quality in the Elbow River* (1993)
- *Report of the Bow River Water Quality Task Force*
- *A Report on the State of the Bow River*
- *Agricultural Impacts on Water Quality in Alberta – An Initial Assessment* (1998)
- *Bacteriological Water Quality of Millburn Creek, 1993 to 1997*
- Background information on
  - policies and procedures for Kananaskis Country
  - operation and monitoring for the Glenmore Water Treatment Plant
  - City of Calgary's policy on extending water and sewer services beyond its boundaries
  - stormwater management within the City of Calgary
  - municipal planning and stormwater management within the M.D. of Rocky View
  - intermunicipal planning between the City of Calgary and the M.D. of Rocky View
  - water quality issues such as suspended sediments, disinfection by-products, *Giardia*, and *Cryptosporidium*
- *Report of the Water Quality Objectives Committee* (Appendix B)
- *Report of the Implementation Committee* (Appendix C)
- *Fisheries Management Objectives for the Upper Elbow River* (Appendix D)
- Existing water licences and effluent discharge approvals (Appendix F)
- Withdrawal and instream uses of the Elbow River
- Water quality guidelines
- Water quality monitoring results
- Water quality trends (Appendix E)
- Methods for estimating flow requirements for instream needs (Appendix F)
- Water quantity objectives (Appendix G)
- Experience of people familiar with water use management in the Elbow River Basin and other jurisdictions

Deliberations: The goal of the Working Group was to achieve consensus, that is, unanimous agreement on the matters that it discussed.

The Working Group held twelve meetings from December, 1997 to October, 1999. The Working Group also visited sites in the upper Elbow Basin associated with urban stormwater management, water withdrawal, water treatment, riparian habitat, logging, grazing, and recreation.

Figure 3 shows a list of the information considered by the Working Group. The Working Group established committees to examine in greater detail the issues of water quality objectives and implementation. The reports of these two committees are provided in Appendices B and C. Appendix C is provided as information to be considered when the Bow River Basin Water Council examines the issue of implementation of instream objectives.

The Elbow River is a relatively small river that provides water to meet a variety of needs. This includes drinking water for almost one-sixth of Albertans, habitat for fish and wildlife, recreational opportunities, and water for livestock.

The value of the Elbow River system will rise in the future with increasing demand for growth and development. The Working Group agreed that, because of its unique nature, the upper Elbow River requires instream objectives that are specially tailored to:

- protect the aquatic and riparian ecosystems
- preserve current and future human use of water in the basin.

There was a high degree of consensus among the Working Group members. However, the Municipal District of Rocky View does not agree with all the recommendations of the Working Group. The M.D.'s concerns are detailed in Appendices B and C.

Conclusions: The Working Group found that, at present, the quantity and quality of water in the upper Elbow River is, in general, good when compared to the requirements for the aquatic ecosystem and human uses. Some deterioration in water quality is occurring, as evidenced by increasing trends in the concentration of four of nine water quality indicators, as analyzed by Alberta Environment from data taken during the time period 1979 to 1997. The four variables for which there are increasing trends are dissolved phosphorus, turbidity, fecal coliforms, and total coliforms (Appendix E). The amount of water allocated through licences has also reached the point where instream objectives will be necessary to protect instream needs such as fish habitat and recreation (Appendix F).

The Working Group believes that co-operative, integrated management of

- water quantity and water quality
- surface water and ground water
- land and water

is essential to protect and sustain the aquatic and riparian environments and maintain adequate water supplies for human use.

The Working Group also believes that stakeholders in the upper Elbow Basin have valuable insights into the management of water use and that their contributions are fundamental to long term, co-operative solutions. This applies to all aspects of water use management, including monitoring, analysis, approval, and enforcement.

The Working Group discussed the cumulative impacts of activities such as:

- septic systems
- land management practices (e.g., residential, recreational, agricultural)
- population growth
- regional servicing
- modifications to the streambed and riparian habitat
- transportation (e.g., dangerous goods, increased erosion from changing the river's course)
- floodplain development and protection as it relates to the potential for increased downstream flooding.

However, the Working Group did not pursue these issues. In most cases, more information is required to resolve them. Cumulative impact will need to be assessed in implementing the recommendations, particularly Recommendation 7.

Recommendations: The Working Group has developed the following recommendations for consideration by Alberta Environment:

1. In making decisions on licences, approvals, and other regulatory matters affecting the upper Elbow River, Alberta Environment should use the following instream objectives:

    a. the water quality objectives listed in Table B-1 of Appendix B

    b. the flow requirements of licensees or approval and registration holders who are downstream of a proposed activity

    c. the flow to maintain fish habitat[1]

    d. the flow to maintain river recreation as follows:[2]

        - in Kananaskis Country and downstream to Bragg Creek
            - preferred flow for very skilled canoeists
        - from Bragg Creek to Highway 22
            - preferred flow for intermediate canoeists
        - from Highway 22 to Glenmore Reservoir
            - minimum flow for canoeing

    e. the instream flow objectives for the Elbow River downstream of Glenmore Dam

    f. the ongoing modification of instream objectives to accommodate new information about flow, water quality, and the inter-relationships between them.[3]

    These objectives will protect and sustain the aquatic ecosystem and the human uses of water including agriculture and industry.

2. Alberta Environment has agreed to pursue a ground water management plan with the Municipal District of Rocky View, the Municipal District of Foothills, and the Tsuu T'ina Nation. Until this ground water plan is completed, it is recommended that, for

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1 Work during the summer of 1999 will provide better information on the fish habitat in the Elbow River and the flow and other factors needed to maintain that habitat. A fisheries inventory has been recommended for the Elbow River. Beyond the work being conducted this summer, resources are currently not available for the inventory. Efforts will continue to secure the resources necessary to complete the inventory.

2 Work beginning in the summer of 1999 will provide better information on the flow needed for river recreation.

3 The Working Group recognizes the importance of updating instream objectives so that they reflect advances in scientific understanding. The Working Group feels that it is particularly important to ensure that the aquatic ecosystem and human uses are not compromised by the combined influence of low flows and reduced water quality.

water well licence applications[4] in the Elbow River Basin, ground water should be treated as if it were surface water unless it is demonstrated that the ground water is not connected to surface water in the basin. New or additional ground water withdrawals should only be allowed if sustainable[5].

NOTE: The Municipal District of Rocky View does not support this recommendation because it believes that ground water was not within the terms of reference of the Working Group. The M.D. feels that, if this recommendation is implemented, it should only apply to water well licence applications within the 1-in-100 year floodplain.

3. In making decisions on licences and/or approvals for water withdrawals affecting the upper Elbow River, Alberta Environment must develop estimates of future demand for water withdrawals (including domestic use) from all municipalities and First Nations upstream and downstream from the proposed withdrawal location and consider this future demand in its decisions.

4. Alberta Environment should require that standardized, written, and verifiable notification of all applications for water withdrawals, diversions, or effluent discharges from or into the upper Elbow River be sent to the Tsuu T'ina Nation and all licensees, municipalities, landowners along the river, and other directly affected groups. Alberta Environment should develop a mailing list for applicants to use.

5. To ensure that the instream objectives are met, there must be an adequately funded program of data collection and analysis that will include:

   a. long-term flow monitoring

   b. water quality analysis

   c. the engagement of qualified, experienced people to provide high quality, impartial, and defensible interpretations and conclusions.

6. In using the instream objectives and other environmental criteria, Alberta Environment's investigators and inspectors should provide a written description of their authority, citing specific legislation and/or regulation for reference, and provide written direction summarizing concerns and proposed changes required to resolve problems. This direction should be followed by a meeting with affected parties to discuss contributing factors and alternative solutions to relevant issues.

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[4] This recommendation would not affect wells for household purposes since those wells do not require a licence under the *Water Act*.

[5] In terms of ground water management, "sustainable" means that ground water withdrawals will not exceed the recharge rate of an aquifer and will not cause unacceptable reduction in the ground water contribution to surface water supply or adverse effects on licensed users and the aquatic and riparian environments.

7. The *Report of the Implementation Committee* (Appendix C) and the additional issues raised by Working Group members (Appendix H) should be referred to the Bow River Basin Water Council for consideration when the Council discusses methods for ensuring that the instream objectives are met.

8. This report should be provided to the governments, organizations, and individuals that participated on the Working Group. Once they have had a chance to familiarize themselves with its contents, the report should be made available to the public for review and comment.

List of Appendices

Appendix A: Terms of Reference

Appendix B: *Report of the Water Quality Objectives Committee*

Appendix C: *Report of the Implementation Committee*

Appendix D: *Fisheries Management Objectives for the Upper Elbow River*

Appendix E: *Evaluation of Recent Trends in Water Quality in the Elbow River Upstream from Glenmore Reservoir*

Appendix F: Data on Instream Flow Methods, Natural Flow, Withdrawal Licences, Effluent Discharge Approvals, and Flow Requirements for Instream Needs

Appendix G: Water Quantity Objectives

Appendix H: Additional Issues Raised

Copies of the *Appendices* can be obtained by calling (toll free 310-0000) 297-3362. Copies of the appendices can also be picked up at:

- Alberta Environment Information Centre, 100, 3115-12 Street NE, Calgary
- Bragg Creek Video Store
- Springbank Park for All Seasons
- Townsite of Redwood Meadows Office
- Tsuu T'ina Nation Office (needs to be confirmed)
- Parks Foundation Calgary Office, 1725, 645-7 Avenue SW, Calgary
- Glenmore Water Treatment Plant, Administration Building, 1668-56 Avenue SW, Calgary
- M.D. of Rocky View Office, 911-32nd Avenue NE, Calgary.

Report

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Upper Elbow River

Instream Objectives Working Group

Appendices

October, 1999

Appendix A

Terms of Reference
Upper Elbow River Instream Objectives Working Group

Bow Basin Plan

Instream Objectives for the Upper Elbow River (Upstream of Glenmore Reservoir)

Working Group
Terms of Reference

1. **Background:** As part of the Bow Basin Plan, instream objectives will be established for the upper Elbow River.

   Residents of the area and local and provincial government agencies have expressed concerns about the environmental impact of land use changes that have occurred or may occur in the basin. Impacts on the flow and quality of water in the Elbow River are key concerns.

   The Elbow River Water Quality Task Force examined the water quality of the Elbow River and, among other things, recommended that:

   - Alberta Environmental Protection, in consultation with local jurisdictions, explore the development of acceptable limits for loadings for key water quality indicators.
   - Alberta Environmental Protection proceed with an Instream Flow Needs (IFN)[1] study for the Elbow Basin.
   - Jurisdictions in the Elbow Basin co-ordinate health and land use planning with river basin planning and the work of the Bow River Water Quality Council[2].

2. **Purpose:** The establishment of instream objectives for the upper Elbow River will provide targets for protecting instream uses and the aquatic and riparian environments. The objectives will strike a balance between instream needs and water withdrawal and effluent discharge.

3. **Scope:** When establishing instream objectives, consideration will be given to all water uses in the basin, the needs of the river ecology and riparian environments, and downstream impacts (including impacts on Glenmore Reservoir). Both the flow and water quality of the river will be included and cumulative effects will be assessed. The impact of land use will be considered.

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1 The term *instream flow needs* has been replaced by:
- *instream needs* - the quantities of water and water quality conditions needed to satisfy instream uses of water and to protect the river ecology and riparian environments
- *instream objectives* - targets for water quantity and quality that are derived through compromises and trade-offs.

2 The Bow River Water Quality Council is now called the Bow River Basin Water Council. Its mandate has been expanded to include the entire Bow River Basin, water quantity, and ground water.

4. **Reporting:** The working group reports to the Planning Team for the Bow Basin Plan.

5. **Tasks:** Under the direction of the Planning Team, the working group will perform the following tasks:

a. Existing Information

i. Review existing information including the reports *Water Quality of the Elbow River* and *Elbow River Water Quality Report*.

b. Instream Needs

i. Review methods for developing instream needs for fish habitat, recreation, ecosystem protection, and protection of municipal water supply.
ii. Review suitability to the upper Elbow River of proposed methods for developing instream needs for fish habitat, recreation, ecosystem protection, and protection of municipal water supply.
iii. Recommend instream needs for fish habitat, recreation, ecosystem protection, and protection of municipal water supply for the upper Elbow River.

c. Withdrawal Demands

i. Review estimates of current and future withdrawal demands in the upper Elbow River Basin.
ii. Recommend data on current and future withdrawal demands in the upper Elbow River Basin for use in scenarios.

d. Water Quality Analysis

i. Review current water quality data and estimates of current and future effluent discharge in the upper Elbow River Basin.
ii. Recommend data on current water quality and current and future effluent discharge in the upper Elbow River Basin for use in scenarios.

e. Evaluation Criteria

i. Review current water management evaluation criteria and data requirements.
ii. Recommend evaluation criteria for scenarios for the upper Elbow River Basin.

f. Scenarios

i. Review future options for water management and relevant land use in the upper Elbow River Basin.
ii. Define and recommend scenarios for assessing instream objectives for the upper Elbow River.
iii. Analyze and evaluate scenarios
iv. Review scenarios with members of the public.

g. Recommended Instream Objectives

i. Draft recommendations on instream objectives for review by the Planning Team.

6. **Participation:** Participation in the activities of the working group will be voluntary. Three types of participation have been identified:

a. member of the working group
b. resource person
c. recipient of information.

Participation will be open to those who have a stake in decisions that could potentially affect the flow and quality of water in the upper Elbow River.

7. **Deadlines:** Proposed deadlines are:

a. Tasks a - e: February 27, 1998
b. Task f: July 15, 1998
c. Task g: August 10, 1998

Appendix B

Report
of the Water Quality Objectives Committee

Bow Basin Plan

Instream Objectives for the Upper Elbow River (Upstream of Glenmore Reservoir)

Report of the Water Quality Objectives Committee

Purposes: The purposes of the Committee were to

1. Review the draft water quality objectives.
2. Decide what objectives should be recommended for protecting water quality in the upper Elbow River.

Membership: The members of the Committee were:

Jamie Dixon, M.Sc., P. Biol.
Biologist, Waterworks Division
Engineering and Environmental Services,
City of Calgary

Laurie Kimber
Municipal Planner
Municipal District of Rocky View

Bob McIntosh
Environmental Scientist
Sewer Division
Engineering and Environmental Services,
City of Calgary

Jane Pearson, M.Sc.
Resident, Townsite of Redwood Meadows

Read Seidner, Ph.D.
Laboratory Superintendent
Waterworks Division
Engineering and Environmental Services,
City of Calgary

Al Sosiak, M.Sc., P. Biol.
Limnologist, Water Sciences Branch
Water Management Division
Natural Resources Service
Alberta Environment

Deliberations: The Committee held seven meetings from September through November, 1998. They considered a variety of information including

- published standards and guidelines
- monitoring data
- experience of professionals familiar with water use management in the Elbow River Basin and other jurisdictions.

Choosing the proper objectives was a process that required extensive discussion. In most cases, the Committee was able to agree on how to express objectives in words. Instances where agreement on wording was not achieved are identified in the objectives.

The determination of numerical objectives was more challenging. For a few variables, there are scientifically-sound numerical objectives that are directly applicable to the upper Elbow River. For most variables, however, the selection of numerical objectives was not straightforward.

Professional judgements were required in a number of instances to compensate for incomplete information on background water quality in the Elbow River, the level of acceptable risk, or criteria for specific uses of water. The rationale for and limitations of the numerical objectives are described in Appendix B-1.

Caveat on Numerical Objectives: The Municipal District of Rocky View did not support the development of numerical objectives. The MD felt that it would be more realistic to have a general statement of what is wanted or to seek to maintain background levels. The MD was also concerned because it is limited in its authority over development (e.g., septic fields, agriculture, Kananaskis Country), yet will be blamed if numerical objectives are not met. The MD noted that, if numerical objectives are appropriate, the provincial government needs to make a commitment to monitor and enforce to meet the objectives. The MD's representative participated in the work of the Committee, but did not pass judgement on the numerical objectives.

Recommended Objectives: The objectives are based on water use. They are described first in words and then, in Table B-1, translated into numerical objectives.

The Committee developed warning levels (or "red flags") that, if exceeded, should result in immediate action to identify the cause and eliminate the problem. Both the instantaneous and average warning levels included in Table B-1 are "red flag" objectives.

The Committee also developed advisory levels (or "yellow flags") that, if exceeded, provide an indication that problems may be developing. Although they do not require immediate action, the advisory levels do require assessment of conditions and causes to determine if remedial action is needed.

Upper Elbow River
Instream Objectives
Working Group

WATER QUALITY OBJECTIVES

Introduction

These objectives were developed from

- water quality objectives proposed by members of the working group
- the water quality objectives used by the Bow River Water Quality Task Force
- the deliberations of the Working Group's Water Quality Objectives Committee.

Each objective has been reviewed to ensure that it is appropriate to the situation in the area drained by the upper Elbow River.

Water quality is a reflection of the health of aquatic and riparian ecosystems. It is measured by the physical, chemical, and biological characteristics of the water and includes variables such as

- the amount of oxygen dissolved in the water
- suspended solids (e.g., silt)
- bacteria
- toxic chemicals
- nutrients such as nitrates and phosphorus.

Water quality can be affected by factors such as

- the type of land the river flows through
- the uses of the land
- the time of year
- the amount and intensity of precipitation
- the interaction of surface and ground water
- the condition of the streambed and riparian habitat
- the management of point and non-point discharges into the river and its tributaries including stormwater run-off and effluent discharged from municipal and industrial wastewater treatment plants.

Water Quality Objectives for the Upper Elbow River

General Objective

- Use best management practices for the management of land use, water withdrawals, and wastewater.

Municipal and Domestic Water Supply Objectives

- Protect both raw water and the watershed to achieve, with a minimum of treatment, drinking water that meets or exceeds the *Canadian Drinking Water Guidelines*, e.g., water used for human consumption must be free of harmful levels of pathogenic organisms (e.g., bacteria, protozoa, and viruses), toxic chemicals, and trace metals.
- Protect both raw water and the watershed for municipal needs.

Recreation and Aesthetic Enjoyment Objectives

- Maintain[1] a high degree of water clarity and quality with a low risk of infection from waterborne pathogens through contact with the water in the river.
- Eliminate sources which encourage enhanced weed and algal growth.
- Protect from hazardous chemicals, oily sheens, and odor-producing substances.
- Maintain the river and its streambanks free of litter and potential contaminants.

Ecosystem Objectives

The upper Elbow River is a cold water ecosystem.

- Maintain high oxygen content and cool water temperatures to ensure a diverse cold water plant and invertebrate community.
- Maintain a non-toxic environment[2] for all aquatic life.
- Ensure fish have no unpleasant taste or odor and fall within the guidelines for human consumption.
- Maintain a healthy aquatic and riparian environment for wildlife and aquatic life.

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1 "Maintain" means no degradation relative to background levels.

2 In terms of water quality management, a non-toxic environment is an ecosystem where there are
   a) no immediate or long-term harmful effects on living organisms
   b) no dangers to the environment upon which human life depends
   c) no dangers to human life or health
   due to people's activities.

Specific Objectives for Protection of Streambed, Shores, and Riparian Habitat

- Prevent or minimize soil erosion associated with land use activities.
- Achieve no net loss of aquatic and riparian habitats.[3]
- Determine the biotic and abiotic requirements of aquatic and riparian species and communities and incorporate habitat considerations in management practices to sustain these requirements.
- Following construction and development, restore the productivity of the streambed and streambanks of water bodies and adjacent habitat.
- No increase in downstream peak flows due to people's activities.
- No increase in stream velocities due to people's activities.
- Permitted work must address aquatic and riparian habitat protection.
- Permit applications must assess projected cumulative impacts.
- Alberta Environment should develop and use strict policies for curtailment and prosecution of unauthorized activities that are not quickly resolved through other means.

Exceptions

The objectives for protecting the streambed, shores, and riparian habitat will not apply to measures that are taken to protect property from flooding if those measures meet the requirements of

- the Canada-Alberta Flood Damage Reduction Program
- bylaws governing land use within a designated floodplain
- the *Water Act*, *Public Lands Act*, *Environmental Protection and Enhancement Act*, *Fisheries Act*, and approvals issued under those laws.

Issues related to flood risk in downstream locations can be raised through the M.D. of Rocky View – City of Calgary Intermunicipal Committee or other appropriate inter-jurisdictional forum.

Definitions

"Bed and shores" as defined in the *Surveys Act*:

> "17(3) ...the bed and shore of a body of water shall be the land covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself."

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3 The Committee did not reach consensus on how to define "riparian habitat". Three alternate definitions were identified:
- a definition based on vegetation, ground water, or other physical characteristics
- the 1-in-100 year floodplain
- the floodway as defined under the Canada-Alberta Flood Damage Reduction Program.

It is recommended that the objectives related to the aquatic ecosystem be interim until such time as a fisheries inventory is completed

Agriculture Objectives

Water quality throughout the basin should be non-limiting to agricultural use.

For livestock watering the objectives are:

- Prevent any bioaccumulative contaminants or pathogenic organisms from developing.
- Maintain low to moderate salt content.
- Maintain non-toxic levels of nitrogen, pesticides, and trace metals.
- Maintain nutrient levels that do not stimulate the production of algal toxins.

The objectives for agriculture will be achieved by meeting the more stringent objectives for ecosystem protection and municipal and domestic water supply.

Industry Objective

- Maintain a water quality that is usable by industry. Weed and algal growth should not impair water withdrawal.

The water quality requirements for industrial water supply vary. It is expected that requirements for industry will be met by meeting the objectives for ecosystem protection and municipal and domestic water supply.

Water Disposal Objective

- Ensure that water disposal (domestic, municipal, and industrial effluent and urban and rural run-off) does not cause the water quality in the Elbow River to exceed the objectives set out in this document.

Numerical Objectives

Numerical objectives for protecting water quality are contained in Table B-1.

NOTE: Other objectives and variables will be added to this list as necessary to deal with emerging issues.

Table B-1
Upper Elbow River: Numerical Water Quality Objectives

Variable	Priority for Additional Work (1 = low priority 10 = high priority)	Warning Level				Advisory Level	
		Instantaneous Value		Average (annual arithmetic mean unless indicated)			
		Value	Rationale / Limitations	Value	Rationale / Limitations	Value	Rationale / Limitations
Municipal Water Supply							
Ammonia	1	Should not exceed 0.04 mg/L in the river	• Protects municipal water supply from unacceptable chlorine demand and taste and odor problems. • Based on experience at Glenmore Water Treatment Plant.				
Bacteria (total coliforms)	10	Should not exceed 500 counts (total coliforms) per 100 mL in the river or 20,000 counts (total coliforms) per 100 mL at intake for Glenmore Water Treatment Plant	• Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water. • US EPA *Guidance Manual* • Requires review of background research and development of objectives for fecal coliforms or *E. coli*.				
Cryptospo-ridium	10	VNE	• Analytical procedures need to be standardized.	VNE	• Analytical procedures need to be standardized.	VNE	• Analytical procedures need to be standardized.

CCME = Canadian Council of Ministers of the Environment VNE = Value not established US EPA = United States Environmental Protection Agency

Warning Levels are targets that, if exceeded, should result in immediate action to identify the cause and eliminate the problem.

Advisory Levels are targets that, if exceeded, provide an indication that problems may be developing. Although they do not require immediate action, they do require assessment of conditions and causes to determine if remedial action is needed.

ABCD = This font indicates where there was not a consensus among Committee members.

Variable	Priority for Additional Work (1 = low priority 10 = high priority)	Warning Level				Advisory Level	
		Instantaneous Value		Average (annual arithmetic mean unless indicated)			
		Value	Rationale / Limitations	Value	Rationale / Limitations	Value	Rationale / Limitations
Giardia	1			Should not exceed 1 cyst per 100 L (geometric mean) in the river or 10 cysts per 100 L at intake to Glenmore Water Treatment Plant	• US EPA *Guidance Manual* • Higher levels of *Giardia* require new water treatment processes for small water supply systems in the Basin. • Over time, as approvals come up for renewal, small water supply systems may be required to upgrade to treat higher levels of *Giardia*.		
Nitrate/ Nitrite	5	Should not exceed 0.160 mg/L in the river	• Protects against stimulation of excessive weed and algal growth to protect municipal water supplies • Based on Committee members' assessment of the current situation. • 90th percentile value based on existing monitoring data			Trend analysis should not show increasing level of nitrate/nitrite in the river.	• Protects the watershed from deterioration to protect municipal water supplies • Based on Committee members' assessment of the current situation. • Trend analysis must take into account factors such as variation in flow and seasonal conditions.
Organic Carbon	5	Should not exceed 4.0 mg/L total organic carbon in the river	• Protects municipal water supplies. • Peak levels of organic carbon currently exceed the level where enhanced coagulation is required. Enhanced coagulation causes increased acidity and thereby increased corrosion products. • 90th percentile value based on existing monitoring data			Trend analysis should not show increasing level of organic carbon in the river.	• Protects municipal water supplies. • Based on Committee members' assessment of the current situation. • Trend analysis must take into account factors such as variation in flow and seasonal conditions.

CCME = Canadian Council of Ministers of the Environment VNE = Value not established US EPA = United States Environmental Protection Agency

Warning Levels are targets that, if exceeded, should result in immediate action to identify the cause and eliminate the problem.

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Variable	Priority for Additional Work (1 = low priority 10 = high priority)	Warning Level				Advisory Level	
		Instantaneous Value		Average (annual arithmetic mean unless indicated)			
		Value	Rationale / Limitations	Value	Rationale / Limitations	Value	Rationale / Limitations
Pesticides and toxic chemicals	1	Should not exceed the lower of: a. < 1/10 of federal drinking water guidelines b. < CCME guidelines for aquatic life in the river	• Protects drinking water and aquatic ecosystems • *Canadian Drinking Water Guidelines* • CCME guidelines				
Phosphorus	5	Should not exceed 0.008 mg/L dissolved phosphorus in the river	• Protects watershed for municipal water supplies. • Dissolved phosphorus is the best indicator of influence on plant growth • There is a trend of increasing phosphorus load in the river. • Phosphorus during periods of snowmelt run-off is not currently at tolerable levels • 90th percentile value based on existing monitoring data			Trend analysis should not show increasing level of dissolved phosphorus in the river.	• Protects watershed for municipal water supplies. • Dissolved phosphorus is the best indicator of influence on plant growth • There is a trend of increasing phosphorus load in the river. • Trend analysis must take into account factors such as variation in flow and seasonal conditions.

CCME = Canadian Council of Ministers of the Environment VNE = Value not established US EPA = United States Environmental Protection Agency

Warning Levels are targets that, if exceeded, should result in immediate action to identify the cause and eliminate the problem.

Advisory Levels are targets that, if exceeded, provide an indication that problems may be developing. Although they do not require immediate action, they do require assessment of conditions and causes to determine if remedial action is needed.

ABCD = This font indicates where there was not a consensus among Committee members.

Variable	Priority for Additional Work (1 = low priority 10 = high priority)	Warning Level				Advisory Level	
		Instantaneous Value		Average (annual arithmetic mean unless indicated)			
		Value	Rationale / Limitations	Value	Rationale / Limitations	Value	Rationale / Limitations
Recreation							
Bacteria (*E. coli*)	1	Should not exceed 298 counts (*E. coli*) per 100 mL in the river	• US EPA guideline for moderate contact recreation. The US EPA recommends that a site-specific guideline be developed.	Should not exceed 126 counts (*E. coli*) per 100 mL in the river	• US EPA guideline to protect contact recreation • Geometric mean of 5 samples in 30 days • The estimated level of risk of illness from swimming is eight per 1,000.		
Ecosystem							
Ammonia	1	Should not exceed the values in Table 3-12 in CCME guidelines as measured in the river	• Table 3-12 is designed to protect aquatic life and takes into account the influence of both temperature and pH on the toxicity of ammonia. • This objective does not represent a value to protect the river against excessive growth of aquatic plants.				
Dissolved oxygen (DO)	5	Should not be less than 6.5 mg/L in the river	• CCME minimum for adult and juvenile cold-water fish • 9.5 mg/L would apply where salmonid fish spawn in gravel. Requires fishery inventory to determine spawning areas.			DAYTIME VALUES SHOULD NOT BE LESS THAN 8.0 MG/L IN THE RIVER	• Current data indicate that an 8.0 mg/L daytime DO is at the lower end of background levels. • This objective would be used to indicate whether or not additional monitoring and analysis is required. • Instantaneous value

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ABCD = This font indicates where there was not a consensus among Committee members.

Variable	Priority for Additional Work (1 = low priority 10 = high priority)	Warning Level				Advisory Level	
		Instantaneous Value		Average (annual arithmetic mean unless indicated)			
		Value	Rationale / Limitations	Value	Rationale / Limitations	Value	Rationale / Limitations
Pesticides and toxic chemicals	1	Should not exceed the lower of: a. < 1/10 of federal drinking water guidelines b. < CCME guidelines for aquatic life in the river	• Protects drinking water and aquatic ecosystems • *Canadian Drinking Water Guidelines* • CCME guidelines				
Suspended solids	6	Should not exceed a 10% increase over background levels for total suspended solids in the river	• Trend analysis has indicated that levels of suspended solids are increasing. • Background levels need to be determined. • Applies to permanent changes in water or land use or alterations to the land.	Should not exceed a 10% increase over background levels for total suspended solids in the river	• Trend analysis has indicated that levels of suspended solids are increasing. • Background levels need to be determined. • Applies to permanent changes in water or land use or alterations to the land.		
Temperature	5			Should not exceed 18°C in the river	• Chronic maximum for mountain whitefish • 7-day mean • Taylor & Barton, *Temperature and Dissolved Oxygen Criteria for Alberta Fishes in Flowing Waters*, EMA, 1992	Should not exceed 18°C in the river	• 18°C is above the maximum of what has been previously recorded. • 18°C in the river upstream of the reservoir is potentially capable of causing higher temperatures in the reservoir and, therefore, downstream fish kills • Instantaneous value
Also see the categories of nitrate/nitrite and phosphorus under "Municipal Water Supply" for objectives designed to protect the watershed.							

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Rationale and Limitations

Objectives may change as more information becomes available. Therefore, implementation of the objectives must include adequate monitoring and the flexibility to incorporate better information.

Ammonia

Historically, monthly ammonia levels at the Glenmore Water Treatment Plant intake have been generally below the 0.02 mg/L detection limit. In terms of water treatment, total ammonia should not exceed 0.04 mg/L. Up to that level, based on experience at the Glenmore Plant, ammonia does not create an unacceptable strain on chlorine demand nor does it result in problems with unacceptable taste and odor associated with the chloramine species in chlorinated water.

Ammonia is a concern for protection of aquatic life. The toxicity of ammonia depends on both the temperature and pH of the water.

The ammonia criteria for aquatic life are too high if the objective is to keep aquatic plant growth under control. (See the section on Nitrate/Nitrite.)

Bacteria

Trend analysis indicates that there are significant increasing trends in the concentration of fecal coliforms and total coliforms in the Elbow River. Additional monitoring should be conducted to identify the source of bacteria.

Based on the US EPA *Guidance Manual*, conventional treatment as employed at the Glenmore Water Treatment Plant can not effectively handle total coliform levels at the intake when they exceed 20,000 counts/100 mL. Higher levels could require a change in treatment strategy and possibly additional forms of disinfection.

A more stringent objective than 20,000 counts/100 mL for total coliforms is necessary to ensure safe drinking water for all water treatment plants in the basin that meet provincial standards for treatment. In the *Guidance Manual*, "direct filtration with flocculation" is the category that appears to correspond most closely with AENV minimum standards. As a result, the level for total coliforms would be 500 counts/100mL. The background research for these numbers needs to be reviewed.

The level of total coliform bacteria is inherently variable. *E. coli*. is less variable and more indicative of contamination from pathogens. *E. coli*. is the preferred measure of risk to human

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health due to bacterial contamination. Numerical objectives for the protection of municipal water supply should be developed for either fecal coliforms or *E. coli* since those bacteria are more directly linked to health problems.

High coliform bacteria levels tend to indicate that other organisms such as viruses and protozoans are likely to be present. Fecal contamination is not currently considered to be a direct indicator for *Giardia* since a correlation between *Giardia* and fecal bacteria has not been established.

Coliform bacteria levels can be a concern for livestock and irrigation, but not for aquatic life.

People perceive the Elbow River to be in pristine condition. They do not expect and likely would have trouble accepting a risk for swimming as high as the eight per 1,000 illness rate associated with the 126 counts (*E. coli*) per 100 mL recommended by the US EPA. In the scientific community, this level of risk is usually perceived as a "low" risk. A "very low" risk is usually considered to be in the range of one in 10,000 to one in 100,000. This issue should be discussed with the public.

The numbers adopted by the CCME for contact recreation (e.g., 200 counts (*E. coli.*) per 100 mL) have been commonly used. Choosing a risk level is a moral judgement that affects children. A more restrictive number will afford better protection.

Dissolved Oxygen (DO)

The numerical objectives for dissolved oxygen should be designed to protect the high quality that is already there. The 6.5 mg/L recommended by the CCME is the most rational and defensible criteria for the instantaneous minimum for dissolved oxygen. It protects adult and juvenile coldwater fish.

The CCME also has a minimum dissolved oxygen guideline of 9.5 mg/L for those areas where early life stages of fish (embryonic and larval stages) are present. This guideline would apply if the fisheries inventory identifies spawning areas in the Elbow River.

Current data indicate that an 8.0 mg/L for daytime DO is at the lower end of background levels. That level can be used to indicate whether or not additional monitoring and analysis is required.

Al Sosiak does not support 8.0mg/L for DO as an advisory level objective. He does not believe that there are scientific data to strictly define the lower end of the current range for dissolved oxygen. He noted that it is likely that minimum daytime dissolved oxygen will drop below 8.0 mg/L. He recommended that more monitoring is needed to determine the natural variability of dissolved oxygen. It was agreed that more monitoring is needed. Noting Al's objections, the other members of the committee felt that 8.0mg/L would be useful as an interim advisory level for decision-makers to consider.

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Giardia and *Cryptosporidium*

Based on the US EPA *Guidance Manual*, the level of *Giardia* cysts expressed as an annual geometric mean must be less than 10 cysts/100 L for the City to be able to safely treat the water for *Giardia* using current practices. Additional treatment such as ozone is required for the City to be able to manage higher levels of *Giardia*.

There are several other water treatment plants that withdraw water from the Elbow River, but these plants have less treatment capability than the Glenmore Water Treatment Plant. Alberta Environment's (AENV) practice is not to require water treatment plants to upgrade to current (new) standards until an upgrade is required for capacity reasons. AENV will likely continue to require water treatment plants with limited financial resources to treat their water to the current minimum standard of 3-log removal of *Giardia*. This level of treatment assumes a raw water *Giardia* level of < 1 cyst/100L.

Analytical procedures need to be standardized for *Cryptosporidium*.

Nitrate/Nitrite

Nitrate/nitrite is a growth factor for aquatic plants. An increase in nitrate/nitrite will generally result in a corresponding increase in aquatic plant growth. There are, however, other factors such as temperature, turbidity, velocity, and the availability of phosphorus that influence the growth of aquatic plants. Values for nitrate/nitrite appear to be satisfactory for the river. No deteriorating trend for nitrogen in the river is discernible from existing data. Nitrate/nitrite levels in the reservoir could be a concern. Higher levels of nitrate/nitrite will cause increased aquatic plant growth in the reservoir and may cause a shift to undesirable plant species (e.g., blue-green algae).

It was decided that the best approach is to ensure that the current situation does not deteriorate.

It was felt that the 90th percentile value for current nitrate/nitrite levels would be a good indication of problems that should be acted on right away. Trend analysis should be used at the advisory level as an indication that problems may be developing. If trend analysis shows that the level of nitrate/nitrite is increasing, then the situation should be assessed to determine if remedial action is needed. Trend analysis must take into account factors such as variation in flow and seasonal conditions.

Nutrients (General)

Work in Canada and the United States on nutrient limits has not yet produced definitive guidelines. In the United States, nutrients are the #1 water quality priority for lakes and the #2 priority for rivers. The U.S. is proposing to develop different guidelines for different regions due to the inherent natural variability in nutrient levels.

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There are currently no published guidelines for phosphorus, nitrate/nitrite, and organic carbon. These are significant issues. Phosphorus is the biggest concern.

Organic Carbon

Current levels of carbon in Glenmore Reservoir are significantly higher than the historical pattern. Now, an increasing amount of chlorine is required to treat the water. Trihalomethanes (THMs) in the finished water are currently around 40 parts per billion (ppb). The current limit in the *Canadian Drinking Water Guidelines* is 100 ppb, but lower limits are being entertained, as has happened in the U.S. It is not acceptable to allow pollution to approach a standard that is expected to become more stringent in the future. If these levels of carbon persist or if the standards are tightened, then the City will need to change its treatment strategy.

No trend in either total or dissolved carbon has been identified in the river. Higher levels of organic carbon in Glenmore Reservoir are presumably due to primary production in the reservoir or urban run-off. The data on organic carbon levels in the reservoir have not been tested for trends.

It was decided that the best approach is to ensure that the current situation does not deteriorate.

The numbers for total organic carbon (TOC) and total THMs at the Glenmore Water Treatment Plant are of concern. According to good treatment industry practice, levels of organic carbon are often over the level where enhanced coagulation is required. The City is reluctant to extensively practice enhanced coagulation because it would lead to increased acidity in the water and thereby increase the level of corrosion products from pipe and valve materials.

It was decided that TOC is the variable to use in the objective since it will always be measured at the water treatment plant and dissolved organic carbon can be predicted from TOC.

The 90th percentile value of current TOC levels was felt to be a good indication of problems that should be acted on right away. Trend analysis should be used at the advisory level as an indication that problems may be developing. If trend analysis shows that level of organic carbon is increasing, then the situation should be assessed to determine if remedial action is needed. Trend analysis must take into account factors such as variation in flow and seasonal conditions.

Pesticides and Toxic Chemicals

The intent is to provide a safety margin to protect against compounds that pose a significant health risk and not to allow increasing pollution to approach a drinking water standard. It was felt that a safety factor of 10 would be a good warning level objective.

Concentrations of organochlorine compounds detected in glacier meltwater are in parts per trillion

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and therefore would not exceed acceptable drinking water goals for municipal water supplies (1/10 of *Canadian Drinking Water Guidelines*).

Phosphorus

The objectives should concentrate on phosphorus rather than some measure of biomass. Measuring biomass (such as benthic algae) is difficult, the relationship between nutrients and biomass for rivers is not well-defined, benthic algae is sensitive to other factors (e.g., light, river gradient), no one is currently measuring biomass in the Elbow River, and it is unlikely that measurements of biomass would occur on a regular basis.

Phosphorus is the biggest concern among nutrients. Dissolved phosphorus is less variable than total phosphorus and provides the best indicator of influence on plant growth.

There are currently no published guidelines for phosphorus. Trend analysis indicates that there is a significant increasing trend in the concentration of dissolved phosphorus in the river. Additional monitoring should be conducted to identify the source of phosphorus. In terms of impact on Glenmore Reservoir, phosphorus currently appears to be at a tolerable level most of the year, but not during periods of run-off from snowmelt. Peak phosphorus levels occur either in June during the time of mountain snowmelt or during March/April if there is local snowmelt in watersheds closer to the reservoir. It was felt that the 90th percentile value for current phosphorus levels would be a good indication of problems that should be acted on right away. Trend analysis should be used at the advisory level as an indication that problems may be developing. If trend analysis shows that the level of dissolved phosphorus is increasing, then the situation should be assessed to determine if remedial action is needed. Trend analysis must take into account factors such as variation in flow and seasonal conditions.

The most significant eutrophication issue for the reservoir appears to be the spring bloom of algae. It is not clear what the source of nutrients for the spring bloom is. It would be possible to conduct modelling to establish a loading guideline for dissolved phosphorus based on an acceptable level of chlorophyll in the reservoir. The preferred way to develop a loading guideline would be to model the effect of phosphorus on the reservoir. However, an analysis of highly variable phosphorus loadings appears to be too intricate at this time.

Dissolved phosphorus is thought to be weakly flow-dependent, although this relationship has not been tested on the Elbow River. There are very extreme values for phosphorus during high flow periods.

Streambed, Shores, and Riparian Habitat

The City needs a high level of protection for its water supply. It wants to head off problems before they develop and thus avoid costly remedial measures. A key issue is controlling

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deterioration of water quality due to changes in land use and alteration to the streambed, shores, and riparian habitat.

There must be recognition of the need to protect existing development in the floodplain and of the current policies, programs, and bylaws that govern floodplain management.

However, the implementation of measures to protect existing development from flooding or to floodproof new development is a significant concern to the City. Glenmore Reservoir can only provide protection against a 1:18 flood. Flood protection measures in the upper part of the basin might significantly increase the downstream flood risk. There are a number of factors to consider in assessing increased flood risk, including increased peak flow, increased velocity, shortened response time, increased frequency of flooding, and increased property damage. In addition to protection of development in the flood fringe, there could be pressure to protect golf courses or other assets located within the floodway.

The City is also concerned with projects for armoring, straightening, or otherwise modifying the river channel. Along with flood protection measures, these projects result in a loss of aquatic and riparian habitat and, by interfering with natural processes, increase the potential for pollution and higher downstream flood risk.

The M.D. of Rocky View's position is that the issue of flooding and flood protection along the Elbow River has already been addressed by the M.D. in Schedule 7 of Bylaw C-4841-97, adopted as part of the Canada-Alberta Flood Damage Reduction Program, which addresses development adjacent to the Elbow River.

There needs to be a mutually agreeable definition of "riparian habitat".

Suspended Solids

A significant increasing trend in turbidity (and, therefore, an increase in total suspended solids (TSS)) has already been identified for the Elbow River. Additional monitoring should be conducted to identify the source of sediment.

Higher levels of TSS require higher amounts of alum to achieve proper levels of coagulation. Aluminum is not toxic to aquatic life at neutral pH. It is very toxic at low pH and there is some evidence that it is toxic in highly alkaline water.

Rapid changes in TSS are difficult for the water treatment process to deal with. Contaminants (e.g., protozoans) adhere or attach to particles in the water. TSS also affects spawning beds and aesthetics.

The Elbow River generally has TSS less than 100 mg/L. Since historical data on TSS are limited,

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a guideline will require development of a predictive equation that estimates TSS from data on turbidity. The Canadian Council of Ministers of the Environment (CCME) guideline of no increase in TSS greater than 10mg/L (when TSS is less than 100 mg/L) is based on a US EPA recommendation designed to prevent impairment of primary biological productivity. This may not be relevant to the Elbow River.

An objective for TSS could apply to either temporary disturbances or long-term changes. It was decided to apply the objective to permanent changes in water or land use or alterations to the land.

"Non-filterable residue" (NFR) is essentially the same as total suspended solids (TSS). The bulk of the historical data is expressed as NFR. TSS has replaced NFR, but the methods for calculating NFR and TSS appear to be the same. Most data in this area are measurements of turbidity. TSS can be predicted from turbidity.

TSS is heavily flow-dependent and a TSS objective would not be relevant unless it takes into account background levels.

Background TSS needs to be defined. There are four steps involved in doing this:

1. Determine what other jurisdictions have done.
2. Define method for estimating background levels
3. Analyze data and establish background levels
4. Determine how the background levels should be applied (e.g., time of year, total [cumulative] annual or seasonal loading vs. instantaneous maximum, type of decision [permits, effluent discharges, land use decision-making])

This work would take approximately two weeks to complete.

It will not be possible to determine "natural" background levels. Instead, the background levels for the recent period of record (last 5-10 years) could be estimated.

Temperature

Better data are required to establish a baseline for temperature. At a minimum, the data base should include temperature during a year with flow in the lowest 25% of all years.

The recommendation of Alberta Environment (Fisheries Management) is, in the absence of better information, to

- focus instream objectives on native species of fish
- protect the most sensitive of the native species.

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The river downstream of Bragg Creek is the reach where the greatest potential exists for impacts that increase water temperatures. In that reach, the presence of one native species - mountain whitefish – has been confirmed.

In the report by Taylor & Barton called *Temperature and Dissolved Oxygen Criteria for Alberta Fishes in Flowing Waters* (EMA, 1992), temperature criteria are identified that would protect native fish species (bull trout, cutthroat trout, mountain whitefish).

The temperature in the reservoir determines the river temperature downstream of the dam. Water temperature in the reservoir has been as high as 22° C to 23°C. This level of water temperature is close to the temperature range that would be lethal to some fish species. Any increases in water temperature in the river above the reservoir will make the situation worse. 18°C in the river upstream of the reservoir is potentially capable of causing higher temperatures in the reservoir and, therefore, fish kills in the reservoir and downstream.

Temperatures lethal to fish would occur in the river downstream of the reservoir well before lethal temperatures are reached upstream of the reservoir. Therefore, an instantaneous temperature objective for the river upstream of the reservoir is not a helpful indicator.

Mitigative measures to reduce the temperature in the reservoir are probably not feasible. Glenmore Reservoir does not stratify in terms of temperature. It would not be possible to thermally stratify the reservoir, regardless of whether or not a stratified reservoir would be desirable.

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Appendix C

Report
of the Implementation Committee

Bow Basin Plan

Instream Objectives for the Upper Elbow River (Upstream of Glenmore Reservoir)

Report of the Implementation Committee

Purposes: The purposes of the Committee were to

1. Review the current institutional framework for water management
2. Decide what recommendations, if any, should be made to ensure effective implementation of instream objectives for the Upper Elbow River.

Neither the Committee nor the Working Group has the mandate to make commitments for financing, provision of services, or participation in initiatives to protect the flow and quality of the Elbow River. Only the responsible individuals, jurisdictions, and organizations can make these commitments.

Representatives of the Municipal District of Rocky View do not have any authority or direction from the MD Council to enter into any negotiations or discussions regarding the implementation of any task force or committee report regarding instream objectives on the Elbow River.

Membership: The members of the Committee were:

Tim Belliveau
President
Westridge Water Supply Ltd.

Don Cockerton
Protected Areas Planner, Natural Resources Service – Bow Region
Alberta Environment

Wayne Fullerton
Councillor
Municipal District of Rocky View

Kit Lewis
Springbank Resident
Member, Bragg Creek Environmental Coalition

Bob Morrison
Planner, Natural Resources Service – Bow Region
Alberta Environment

Don Schultz, MCIP, ACP
Planner, City, Community and Downtown Division
Planning and Building Department, City of Calgary

Read Seidner, Ph.D.
Laboratory Superintendent
Waterworks Division
Engineering and Environmental Services, City of Calgary

Caveats on Implementation: The Municipal District of Rocky View is of the view that the jurisdiction and mandate for water quality monitoring and standards, and thus funding, lies solely with Alberta Environment.

The MD representatives on the Working Group do not have Council direction to participate in the formulation of a watershed committee and, therefore, the formulation of Recommendation #1. The MD has a *Municipal Development Plan*, a *Land Use Bylaw*, various area structure plans, and subdivision and development policies which together regulate subdivision and development in the MD, including those areas which might be considered riparian habitat and those areas adjacent to the Elbow River. These bylaws are the primary policy documents which regulate land use and development adjacent to the Elbow River, as well as throughout the entire MD. The MD also has in place an Inter-Municipal Development Plan with the City of Calgary which is the primary document providing a framework for inter-municipal relations in terms of subdivision, land use and development. Further, the MD participates with the City of Calgary in a regular inter-municipal forum, known as the Inter-Municipal Committee, which is the venue where issues of mutual concern between the two municipalities are discussed.

The MD does not agree with Recommendation #2. The MD believes that ground water withdrawals are totally and completely out of the scope of the Upper Elbow River Instream Objectives Working Group. The MD is of the opinion that there is quite a clear difference between ground water and surface water, except only for ground water that is clearly connected to a river or a stream in a riparian zone.

Deliberations: The Committee held two meetings in November and December, 1998. They considered a variety of information including

- water quality objectives drafted by the Water Quality Committee
- jurisdictional responsibilities of the federal, provincial, and municipal governments
- key laws and other institutional arrangements
- current methods of implementing instream objectives (IO)
- issue-based assessment of methods of implementing IO.

Appendix C-1 includes a summary of jurisdictional responsibilities, key laws and other institutional arrangements, and current methods of implementing IO.

The Committee feels that current methods cover most aspects of implementing IO. Concerns were expressed about whether certain policies, laws, and other arrangements were being used as effectively as they could be to protect the river's flow and quality. These concerns focused on the issues of sewage treatment (including the approval and functioning of septic fields), land use approvals, flood risk management, agricultural practices and run-off, and ground water and surface water withdrawals. The Committee did not conduct an analysis of how effectively methods of implementing IO are being used. The Committee expects that the question of implementation effectiveness would be a key topic that the proposed Elbow Watershed Committee (see below) could address.

It is important to recognize who is responsible for managing water quality and quantity in the Elbow River Basin. Within its jurisdiction and the extent of its authority, each level of

government regulates activities that, if managed inappropriately, can have an adverse effect (individually or collectively) on the flow or quality of water.

Regulation of changes in the flow and quality of water (including alteration of the bed and shores of water bodies) is the responsibility of the federal and provincial governments through laws such as the *Environmental Protection and Enhancement Act*, *Water Act*, *Public Lands Act*, and *Fisheries Act*. Under these laws, standards and guidelines for water use and effluent discharge are established and monitoring, investigation, and enforcement are conducted. These laws can also govern the management of land adjacent to water bodies.

Water users, those who discharge sewage or stormwater, and others who directly affect the flow and quality of water are required to have approval for their activities. These approvals must be granted by the provincial government and, in some cases, the federal government. The management of water and the associated land must comply with the approval(s). Those who hold approvals are sometimes required to monitor their activities and ambient conditions, while, in some cases, their monitoring activities are conducted voluntarily.

Other activities that indirectly create an adverse effect on the flow and quality of water are investigated and may result in prosecution or a requirement for an approval from the appropriate agency.

Municipalities do not have explicit jurisdiction in the areas of approving municipal or private wastewater disposal systems and water uses within their jurisdiction. Municipal development policies provide standards for stormwater management and policies to guide development adjacent to rivers and streams (e.g., requirements for stormwater ponds, designation of floodplains, and bylaws such as the City of Calgary's *Glenmore Park Bylaw* that regulates the use of the reservoir and adjacent parkland).

Alberta's *Land Use Policies* recognize the importance of having municipal and provincial planning efforts utilize consistent approaches and pursue a high level of co-operation and co-ordination. The importance of having municipal planning efforts complement provincial policies and initiatives is also recognized. The *Land Use Policies* encourage municipalities to take a variety of initiatives to

- foster inter-jurisdictional co-operation and co-ordination
- contribute to maintenance and enhancement of the natural environment and protection and sustainable utilization of water resources.

Within the constraints and opportunities provided in federal and provincial legislation, the most suitable mechanisms for providing policies and guidelines for land development are municipal statutory plans and water management plans. The instream objectives for the upper Elbow River will be incorporated into the Water Management Plan for the Bow River Basin. Each municipality has the authority to decide whether or not to incorporate instream objectives into its

will be incorporated into the Water Management Plan for the Bow River Basin. Each municipality has the authority to decide whether or not to incorporate instream objectives into its municipal plans. In addition, any inter-municipal issues related to water quality may be addressed through inter-municipal planning processes and by inter-municipal committees.

The Committee identified four aspects of IO implementation that require strengthening:

- Long-term monitoring that is adequately funded, impartial, and of the highest quality
- Regular, multi-jurisdictional review of monitoring results
- Effective resolution of issues arising from monitoring, including the impact of the cumulative effects of water and land use
- Education.

Agencies, groups, or individuals could do things to improve effectiveness in these areas. However, the Committee believes that significant benefits in these areas will best be achieved through formation of a co-operative group to plan and assess monitoring and direct efforts at education and issue-resolution.

It is expected that this co-operative group would meet annually. The Bow River Basin Water Council should be responsible for convening the group and co-ordinating input.

The primary advantages of a co-operative group are:

- **better monitoring** and **better information** due to pooled resources, economies of scale, better ability to meet multiple needs, and clearer objectives, procedures, and criteria
- **reduced risk**[1] since better information will eliminate groundless fears and pinpoint serious problems, while joint action will decrease threats to water supplies and the aquatic environment
- **greater consistency** and **reduced inter-jurisdictional conflicts** because of the opportunity to have focused, face-to-face discussion of issues using scientifically-sound, mutually-accepted data
- **increased public confidence** from better information, reduced risk, and greater consistency and co-operation.

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1 "Reduced risk" means less chance of unacceptable impacts on the economy, health, safety, and quality of life. It also means less chance of using limited resources to pursue low priority issues.

To ensure that a co-operative group is effective, the Committee feels that:

- Members of the co-operative group should be from those governments or agencies with responsibility for regulating activities that could affect the river.
- Members of the co-operative group should be people who can implement or obtain approval to implement the decisions of the group. They must be sufficiently empowered to effectively deal with broad, complex issues, some of which are not clearly defined and are outside the traditional mandate or programs of agencies.

Recommendations:

1. AN ELBOW WATERSHED COMMITTEE SHOULD BE FORMED TO PLAN AND ASSESS MONITORING AND DIRECT EFFORTS AT EDUCATION AND ISSUE-RESOLUTION. THE GOALS OF THE COMMITTEE WILL BE BETTER MONITORING AND INFORMATION, REDUCED RISK, GREATER CONSISTENCY AND REDUCED CONFLICT AMONG JURISDICTIONS, AND INCREASED PUBLIC CONFIDENCE.

   DRAFT TERMS OF REFERENCE FOR SUCH A COMMITTEE ARE PROVIDED IN APPENDIX C-2.

2. FOR WATER USE APPLICATIONS, GROUND WATER SHOULD BE TREATED AS IF IT WERE SURFACE WATER UNLESS IT IS DEMONSTRATED THAT THE GROUND WATER IS NOT CONNECTED TO SURFACE WATER IN THE BASIN. NEW OR ADDITIONAL GROUND WATER WITHDRAWALS SHOULD ONLY BE ALLOWED IF SUSTAINABLE[2].

3. Long-term monitoring and analysis of the river's flow and quality must be impartial, adequately funded, and of the highest quality to ensure that the results are accepted.

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2 In terms of ground water management, "sustainable" means that ground water withdrawals will not exceed the recharge rate of an aquifer and will not cause unacceptable reduction in the ground water contribution to surface water supply or adverse effects on licensed users and the aquatic and riparian environments.

ABCD = THIS FONT INDICATES WHERE THERE WAS NOT A CONSENSUS AMONG COMMITTEE MEMBERS.

Appendix C-1

Summary of Jurisdictional Responsibilities, Key Laws and Other Institutional Arrangements, and Current Methods of Implementing Instream Objectives

Table C-1
Key Jurisdictional Responsibilities
Related to Protection of the Flow and Quality of the Elbow River

Federal government

- Authorizations under the *Fisheries Act*
- Authorizations under the *Navigable Waters Protection Act*
- Approvals under the *Indian Act* and associated jurisdiction
- Flood damage reduction

Provincial government

- Water withdrawal licences
- Approvals for instream activities
- Water treatment approvals
- Effluent discharge approvals
- Septic tank installation
- Codes of practice
- Regulation of environmental impact from agricultural operations
- Timber harvesting approvals
- Kananaskis Country land use and development
- Management of beds and banks of river
- Management of fish and wildlife habitat
- Flood damage reduction

Health Authority

- *Public Health Act* enforcement

Municipalities (in general)

- Land use and development

City of Calgary

- Utility services
- City of Calgary *Charter*

Tsuu T'ina Nation

- Land use and development
- Utility services
- Aboriginal and treaty rights

Inter-municipal Committees

- Inter-municipal agreements
- Emerging issues

Bow River Basin Water Council

- Information-sharing
- Emerging issues

Table C-2
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Bed and shore of water bodies (Also see "Forested Land (Green Area)")	*Public Lands Act*	• The *Public Lands Act* regulates the administration, allocation, and management of public land resources in Alberta.	• LFS, AENV • PLS, AAFRD	• A permit is required for most activities that would affect the bed and shores of a water body. • Shoreland Management Program • Enforcement • Riparian land use practices
	Water Act	• The *Water Act* governs the diversion and use of water in Alberta. It regulates actions that interfere with water and water use management.	• NRS, AENV	• An approval is required before alterations are made to the bed and shores of a water body. • Enforcement • Fisheries habitat protection practices • Instream construction practices • Stormwater management
	Municipal Government Act (MGA)	• The MGA establishes the powers of municipalities in Alberta. • The MGA defines the limits of municipal authority and is subject to other provincial legislation including the *Public Lands Act* and the *Water Act*.	• Municipality	• Municipal by-laws • Municipal plans • Land use guidelines
Conflicts between farmers and non-farmers	*Agricultural Operation Practices Act*	• The *Agricultural Operation Practices Act* provides the framework for resolving conflicts between farmers and non-farmers in Alberta.	• AAFRD	• Feedlot management practices • Land use guidelines • Pesticide application practices
Contaminated sites	*Environmental Protection and Enhancement Act*	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• Management of contaminated sites • Enforcement • Management of petroleum storage tanks
	Canadian Environmental Protection Act (EPEA)	• The *Canadian Environmental Protection Act* governs a variety of environmental issues such as federal-provincial co-operation and control of toxic substances.	• EC • CCME	• Toxic substances are regulated through regulations and lists of priority, toxic, hazardous, and prohibited substances. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances*
Education			• AENV	• Environmental Education Program • Information Centre • Environmental education practices
Environmental assessment	*Environmental Protection and Enhancement Act* (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV • Natural Resources Conservation Board	• For some projects, an environmental impact assessment is mandatory. • *Canada-Alberta Agreement for Environmental Assessment Co-operation* • Environmental assessment practices
	Canadian Environmental Assessment Act (CEAA)	• CEAA makes environmental assessment an integral part of federal government decisions. • The federal government conducts environmental assessments when a federal agency is a participant in or regulator of a project.	• Canadian Environmental Assessment Agency	• *Canada-Alberta Agreement for Environmental Assessment Co-operation* • Environmental assessment practices

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BRBWC = Bow River Basin Water Council
DFO = Department of Fisheries and Oceans (Canada)
ES = Environmental Service
NRS = Natural Resources Service
PPWB = Prairie Provinces Water Board
AAFRD = Alberta Agriculture, Food and Rural Development
CCME = Canadian Council of Ministers of the Environment
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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Fish and fish habitat	*Fisheries Act*	• The *Fisheries Act* provides regulation and protection of fisheries.	• DFO • NRS, AENV	• An authorization may be required when a project will result in destruction of fish habitat. • Regulations govern the deposit of substances deleterious to fish. • Enforcement • Fisheries habitat protection practices • Instream needs determination
Forested land (Green Area) [Also see "Bed and shores..." and "public lands in White Area"]	*Forests Act*	• The *Forests Act* provides jurisdiction, control, and administration over all matters in any way connected with timber on Crown land in Alberta.	• LFS, AENV	
	Public Lands Act	• The *Public Lands Act* regulates the administration, allocation, and management of public land resources in Alberta.	• LFS, AENV • PLS, AAFRD	• A permit is required for most activities that would affect the bed and shores of a water body. • Shoreland Management Program • Enforcement
				• Land use guidelines • Pesticide application practices • Riparian land use practices
Hazard reduction			• NRS, AENV	• Alberta Water Management and Erosion Control Program • Canada-Alberta Flood Damage Reduction Program • Flood damage management practices • Dam safety management practices • Erosion control practices
				• Alberta Cloud Seeding Project
Hazardous wastes	*Canadian Environmental Protection Act*	• The *Canadian Environmental Protection Act* governs a variety of environmental issues such as federal-provincial co-operation and control of toxic substances.	• EC • CCME	• Toxic substances are regulated through regulations and lists of priority, toxic, hazardous, and prohibited substances. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances*
	Environmental Protection and Enhancement Act (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• Hazardous materials within Alberta are tracked from "cradle to grave" through a manifest system specified in the Act and regulations. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances* • Enforcement • Hazardous wastes management practices • Landfill management practices • Waste management practices

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Irrigation districts	*Irrigation Act*	• The *Irrigation Act* governs all activities and operations of irrigation districts in Alberta.	• Irrigation Council • Irrigation districts • AAFRD	• Irrigation district by-laws • Licences for irrigation districts and provincial projects that supply water to irrigation districts. • Water use management policies and programs of irrigation districts. • Irrigation Rehabilitation Program
			• Alberta Irrigation Projects Association	
Land reclamation	*Environmental Protection and Enhancement Act* (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• An approval is required for designated industrial activities to ensure that land is properly reclaimed. • Enforcement • Land reclamation practices
Navigation	*Navigable Waters Protection Act*	• The *Navigable Waters Protection Act* protects the navigability of rivers and lakes.	• DFO	
Obstructions	*Public Lands Act*	• The *Public Lands Act* regulates the administration, allocation, and management of public land resources in Alberta.	• LFS, AENV • PLS, AAFRD	• A permit is required for most activities that would affect the bed and shores of a water body. • Shoreland Management Program • Enforcement
	Water Act	• The *Water Act* governs the diversion and use of water in Alberta. It regulates actions that interfere with water and water use management.	• NRS, AENV	• A licence and/or approval is required before an obstruction is placed in a stream or alterations are made to the bed or shores of a water body • Enforcement
	Fisheries Act	• The *Fisheries Act* provides regulation and protection of fisheries.	• DFO • NRS, AENV	• An authorization may be required for an obstruction such as a dam. • A fish way or compensation may be required. • Enforcement
	Navigable Waters Protection Act	• The *Navigable Waters Protection Act* protects the navigability of rivers and lakes.	• DFO	• Enforcement
Phosphorus and other nutrients in detergents	*Canadian Environmental Protection Act*	• The *Canadian Environmental Protection Act* governs a variety of environmental issues such as regulation of nutrients in cleaning agents.	• EC • CCME	• Regulations set the maximum concentration of nutrients in cleaning agents. • Enforcement

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Pollution	*Environmental Protection and Enhancement Act* (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• An approval is required before wastewater can be discharged into a water body. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances* • Enforcement • Guidelines • Instream needs determination • Pesticide application practices • Standards • Stormwater management • Waste management practices
	Canadian Environmental Protection Act	• The *Canadian Environmental Protection Act* governs a variety of environmental issues such as federal-provincial co-operation, environmental quality objectives and guidelines, codes of practice, control of toxic substances, and regulation of nutrients in cleaning agents.	• EC • CCME	• Toxic substances are regulated through regulations and lists of priority, toxic, hazardous, and prohibited substances. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances* • *Canadian Water Quality Guidelines*
	Public Health Act	• The *Public Health Act* is directed towards protecting the health of the public in Alberta and is very broad in application.	• Calgary Regional Health Authority • Alberta Health	• Governs location, operation, maintenance, equipping, cleansing, and disinfecting of wells, water fountains, cisterns, and water tanks.
	Fisheries Act	• The *Fisheries Act* provides regulation and protection of fisheries.	• DFO • NRS, AENV	• Regulations govern the deposit of substances deleterious to fish. • Enforcement • Instream needs determination
	Plumbing and Drainage Act	• In Alberta, the *Plumbing and Drainage Act* governs all water and wastewater plumbing within the property line, including septic tank and tile drainage systems.	• Alberta Labour	• All installations of septic fields and other subsurface disposal systems require a permit. • Septic systems management practices
		• The *Master Agreement on Apportionment* applies to drainage basins shared by the prairie provinces.	• PPWB	• *Master Agreement on Apportionment* • Interprovincial water quality objectives • Forum for resolving issues among the prairie provinces.
			• BRBWC	• Forum for information-sharing and discussion • State of the river report • Survey of urban water use management • Joint stakeholder projects
			• NRS, AENV	• Surface Water Quality Monitoring and Assessment Program
			• AAFRD • Livestock Expansion and Development Team	• Alberta Environmentally Sustainable Agriculture (AESA) program • Agricultural Impacts on Water Quality in the Crowfoot Creek Watershed • Feedlot management practices
			• Trout Unlimited Canada	• Yellow Fish Road™ program

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Potable water supplies	*Water Act*	• The *Water Act* governs the diversion and use of water in Alberta. It regulates actions that interfere with water and water use management.	• NRS, AENV	• Except for domestic use in some situations, a licence is required before water is diverted from an aquifer or other water body. • Enforcement
	Environmental Protection and Enhancement Act (EPEA)	• EPEA regulates the treatment of water for drinking water and other household purposes.	• ES, AENV	• An approval may be required if water will be supplied to others for drinking water and other household purposes. • A certificate of qualification is required for an operator of a municipal water treatment plant. • Enforcement
	Public Health Act	• The *Public Health Act* is directed towards protecting the health of the public in Alberta and is very broad in application.	• Calgary Regional Health Authority • Alberta Health	• Governs the location, operation, maintenance, equipping, cleansing, disinfecting, and disinfestation of wells, water fountains, cisterns, and water tanks.
Public land in White Area	*Public Lands Act*	• The *Public Lands Act* regulates the administration, allocation, and management of public land resources in Alberta.	• LFS, AENV • PLS, AAFRD	• A permit is required for most activities that would affect the bed and shores of a water body. • Shoreland Management Program • Enforcement • Riparian land use practices
	Municipal Government Act (MGA)	• The MGA establishes the powers of municipalities in Alberta. • The MGA defines the limits of municipal authority and is subject to other provincial legislation including the *Public Lands Act* and the *Water Act*.	• Municipality	• Municipal by-laws • Municipal plans • Land use guidelines
				• Alberta Water Management and Erosion Control Program • Pesticide application practices
Recreation and tourism			• NRS, AENV	• Recreation and Protected Areas Program • Canadian Heritage Rivers System • Special Places • Instream needs determination
			• Parks Canada	• Banff-Bow Valley Study
				• Golf course construction/operation practices
Riparian habitat			• Trout Unlimited Canada	• Bow River Project
				• Alberta Water Management and Erosion Control Program (for enhancement of fish and waterfowl habitat) • Instream needs determination • Land use guidelines • Pesticide application practices • Riparian land use practices

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Stormwater management	*Water Act*	• The *Water Act* governs the diversion and use of water in Alberta. It regulates actions that interfere with water and water use management.	• NRS, AENV	• An approval or licence may be required for the impoundment or discharge of stormwater. • Enforcement • Guidelines
	Environmental Protection and Enhancement Act (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• An approval may be required for discharge of stormwater to a water body. • Enforcement • Standards • Stormwater management practices
			• BRBWC	• Forum for information-sharing and discussion • State of the river report • Survey of urban water use management • Joint stakeholder projects
Subdivision approvals	*Municipal Government Act* (MGA)	• The MGA establishes the powers of municipalities in Alberta. • The MGA defines the limits of municipal authority and is subject to other provincial legislation including the *Public Lands Act* and the *Water Act*.	• Municipality	• Municipal by-laws • Municipal plans • Land use guidelines
	Public Lands Act	• The *Public Lands Act* regulates the administration, allocation, and management of public land resources in Alberta.	• LFS, AENV • PLS, AAFRD	• A permit is required for most activities that would affect the bed and shores of a water body. • Shoreland Management Program • Enforcement • Riparian land use practices
				• Flood Damage Reduction Program may result in restrictions on development in floodplains.
Sustainable development	*Environmental Protection and Enhancement Act* (EPEA)	• EPEA regulates the treatment of water for drinking water and other household purposes.	• ES, AENV • Sustainable Development Co-ordinating Council (SDCC)	• Environmental assessment is a key tool for ensuring sustainable development. • The SDCC co-ordinates, reviews and makes recommendations on matters related to sustainable development and protection of the environment. • Enforcement • Environmental assessment practices
	Canadian Environmental Assessment Act (CEAA)	• CEAA makes environmental assessment an integral part of federal government decisions.	• Canadian Environmental Assessment Agency	• *Canada-Alberta Agreement for Environmental Assessment Co-operation* • Environmental assessment practices
			• AAFRD • Irrigation Council	• Alberta Environmentally Sustainable Agriculture (AESA) program
			• AENV	• Integrated resource planning program • Bow Basin Plan • Water quality and quantity modelling
			• NRS, AENV	• Flood Damage Reduction Program • Special Places

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Sustainable development (continued)			• BRBWC	• Forum for information-sharing and discussion • State of the river report • Survey of urban water use management • Joint stakeholder projects
			• Parks Canada	• Banff-Bow Valley Study • Aquatic Ecosystem Strategy Proposal for the Mountain District Parks
				• *Convention on Biological Diversity* • North American Waterfowl Management Plan • Prairie Conservation Action Plan
Timber harvesting	*Forests Act*	• The *Forests Act* provides jurisdiction, control, and administration over all matters in any way connected with timber on Crown land in Alberta.	• LFS, AENV	• Timber harvesting on public land requires a timber licence or a timber permit (under an approved forest management agreement (FMA)). • Timber harvesting must comply with regulations and planning / operating ground rules (within an FMA). • Enforcement
Toxic substances	*Canadian Environmental Protection Act*	• The *Canadian Environmental Protection Act* governs a variety of environmental issues such as federal-provincial co-operation and control of toxic substances.	• EC • CCME	• Toxic substances are regulated through regulations and lists of priority, toxic, hazardous, and prohibited substances. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances* • Enforcement
	Environmental Protection and Enhancement Act (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substances* • Enforcement • Hazardous wastes management practices • Pesticide application practices • Waste management practices
Wastewater treatment - municipal and industrial	*Environmental Protection and Enhancement Act* (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• An approval is required for construction/operation of wastewater treatment facilities and the discharge of wastewater into a water body. • A certificate of qualification is required for an operator of a wastewater treatment plant. • Effluent discharge approvals • Municipal and industrial water use management policies and programs. • Enforcement • Guidelines • Industrial and commercial pretreatment of wastewater • Instream needs determination • Standards • Water and wastewater treatment

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Wastewater treatment - private	*Plumbing and Drainage Act*	• In Alberta, the *Plumbing and Drainage Act* governs all water and wastewater plumbing within the property line, including septic tank and tile drainage systems.	• Alberta Labour	• All installations of septic fields and other subsurface disposal systems require a permit. • Septic systems management practices
Water quality	*Environmental Protection and Enhancement Act* (EPEA)	• EPEA provides the regulatory framework for environmental protection in Alberta.	• ES, AENV	• Approvals or registrations are required to ensure proposed activities that could cause an adverse effect on the environment are reviewed and operated in accordance with regulatory standards. • Enforcement • Guidelines • Instream needs determination • Pesticide application practices • Snow disposal management practices • Standards • Stormwater management
	Canada Water Act	• The *Canada Water Act* provides a framework for managing water resources and co-ordinating activities of various jurisdictions.	• EC	• If required, water quality management areas can be established to provide additional power to regulate pollution.
	Canadian Environmental Protection Act	• The *Canadian Environmental Protection Act* governs a variety of environmental issues such as federal-provincial co-operation, environmental quality objectives and guidelines, codes of practice, control of toxic substances, and regulation of nutrients in cleaning agents.	• EC • CCME	• Toxic substances are regulated through regulations and lists of priority, toxic, hazardous, and prohibited substances. • *Agreement on the Equivalency of Federal and Alberta Regulations for the Control of Toxic Substance* • *Canadian Water Quality Guidelines* • Enforcement
	Fisheries Act	• The *Fisheries Act* provides regulation and protection of water quality for fish.	• DFO • NRS, AENV	• Regulations govern the deposit of substances deleterious to fish • Enforcement • Instream needs determination.
	Public Health Act	• The *Public Health Act* is directed towards protecting the health of the public in Alberta and is very broad in application.	• Calgary Regional Health Authority • Alberta Health	• Governs the location, operation, maintenance, equipping, cleansing, disinfecting, and disinfestation of wells, water fountains, cisterns, and water tanks.
	Plumbing and Drainage Act	• In Alberta, the *Plumbing and Drainage Act* governs all water and wastewater plumbing within the property line, including septic tank and tile drainage systems.	• Alberta Labour	• All installations of septic fields and other subsurface disposal systems require a permit. • Septic systems management practices
	Riparian rights	• Subject to the *Water Act* and the *Environmental Protection and Enhancement Act*. • Governs water use by owners of land adjoining a watercourse.		

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Water quality (continued)			• BRBWC	• Forum for information-sharing and discussion • State of the river report • Survey of urban water use management • Joint stakeholder projects
			• AAFRD • Livestock Expansion and Development Team	• Alberta Environmentally Sustainable Agriculture (AESA) program • Agricultural Impacts on Water Quality in the Crowfoot Creek Watershed • Feedlot management practices • Riparian land use practices
		• The *Master Agreement on Apportionment* applies to drainage basins shared by the prairie provinces.	• PPWB	• *Master Agreement on Apportionment* • Interprovincial water quality objectives • Forum for resolving issues among the prairie provinces.
			• Trout Unlimited Canada	• Yellow Fish Road™ program
Water use	*Water Act*	• The *Water Act* governs the diversion and use of water in Alberta. It regulates actions that interfere with water and water use management.	• NRS, AENV	• Except for domestic use in some situations, a licence is required before water is diverted from a water body. • Water use management policies and programs of water users • Enforcement • Guidelines • Water and wastewater treatment practices
			• BRBWC	• Forum for information-sharing and discussion • State of the river report • Survey of urban water use management • Joint stakeholder projects
	Riparian rights	• Subject to the *Water Act* and the *Environmental Protection and Enhancement Act*. • Governs water use by owners of land adjoining a watercourse.		
	Natural Resources Transfer Agreement	• Gave the Government of Alberta ownership of most water and other natural resources within Alberta.		
		• Apportionment of the flow of the St. Mary and Milk Rivers	• International Joint Commission	• *Boundary Waters Treaty*
		• The *Master Agreement on Apportionment* applies to drainage basins shared by the prairie provinces.	• PPWB	• Formula for sharing interprovincial water among the prairie provinces • Forum for resolving issues among the prairie provinces

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Table C-2 (continued)
Guide to Key Laws and Other Institutional Arrangements

Issue	Laws	Jurisdiction	Organization	Other Arrangements
Water wells	*Water Act*	• The *Water Act* governs the diversion and use of water in Alberta. It regulates actions that interfere with water and water use management.	• NRS, AENV	• Except for domestic use in some situations, a licence is required before water is diverted from an aquifer. • Enforcement • Ground water management practices • Water well management practices
	Environmental Protection and Enhancement Act (EPEA)	• EPEA regulates water well drilling and the treatment of water for drinking water and other household purposes.	• ES, AENV	• An approval may be required if water will be supplied to others for drinking water and other household purposes. • Enforcement
Wildlife and wildlife habitat	*Wildlife Act*	• The *Wildlife Act* provides the regulatory framework for the protection and use of wildlife in Alberta.	• NRS, AENV	• Enforcement • Land use guidelines • Pesticide application practices • Raptor protection practices • Riparian land use practices

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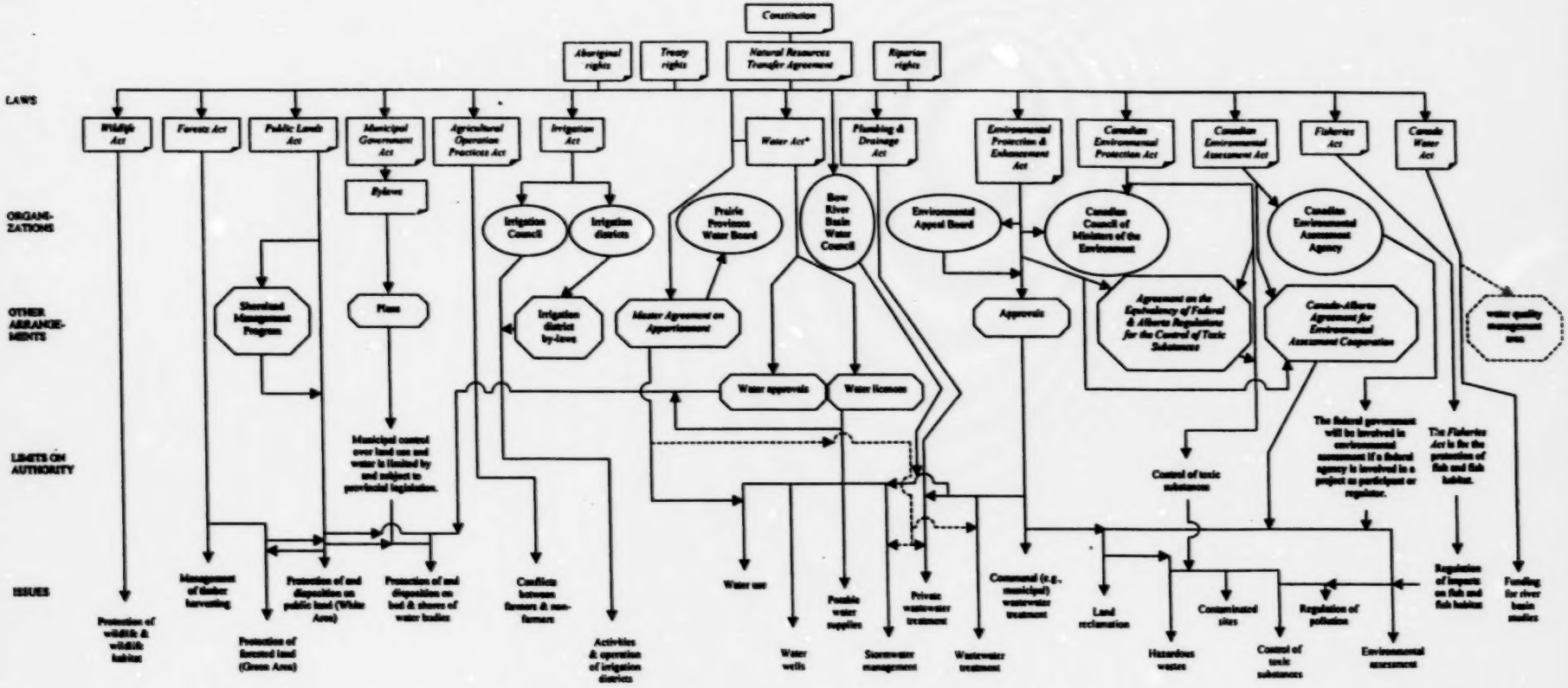
Figure C-1

Key Laws and Other Institutional Arrangements

WATER QUALITY MANAGEMENT



* On January 1, 1999, the *Water Act* replaced the *Water Resources Act*.

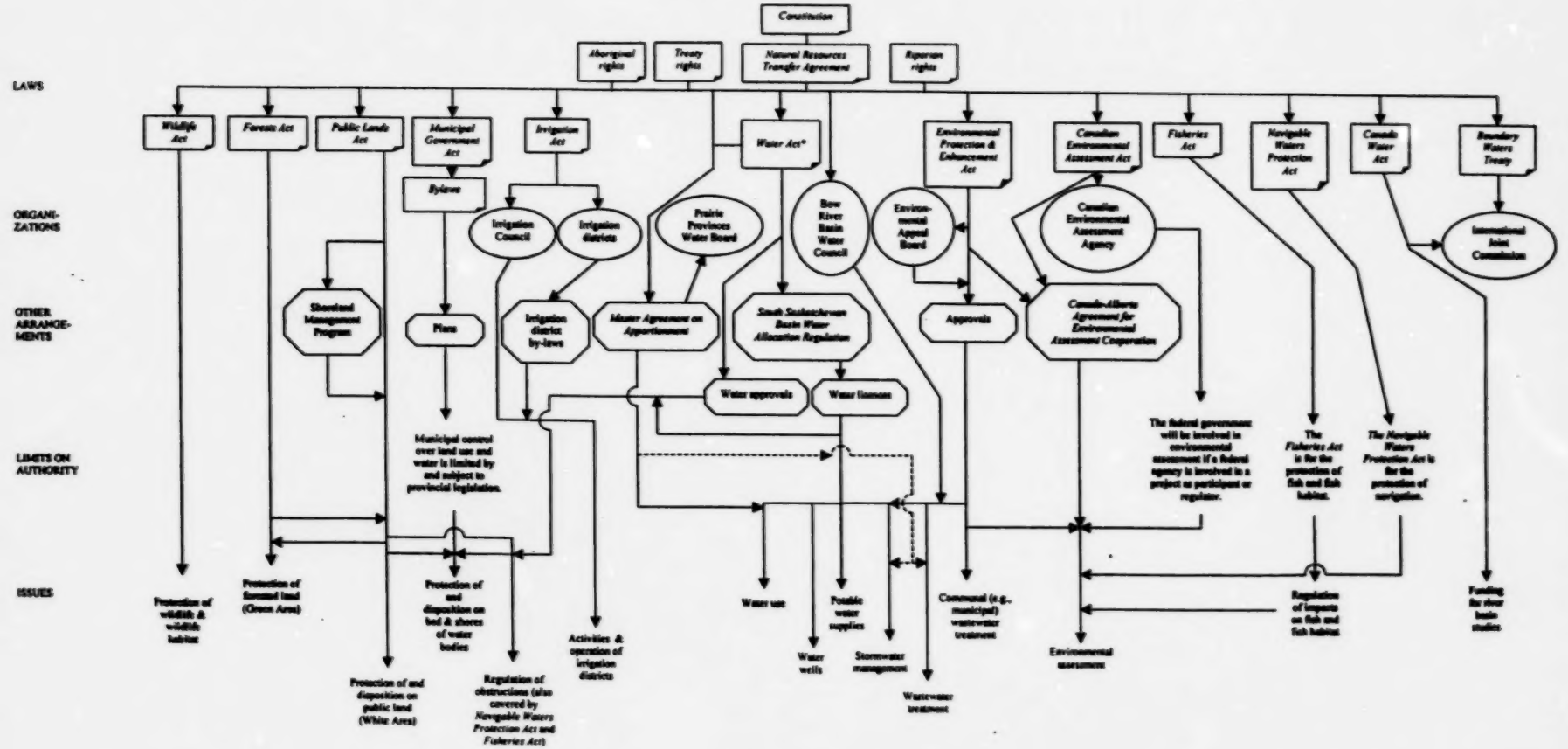
KEY:

Law | Organization | Program | Other arrangement

Figure C-2

Key Laws and Other Institutional Arrangements

WATER QUANTITY MANAGEMENT

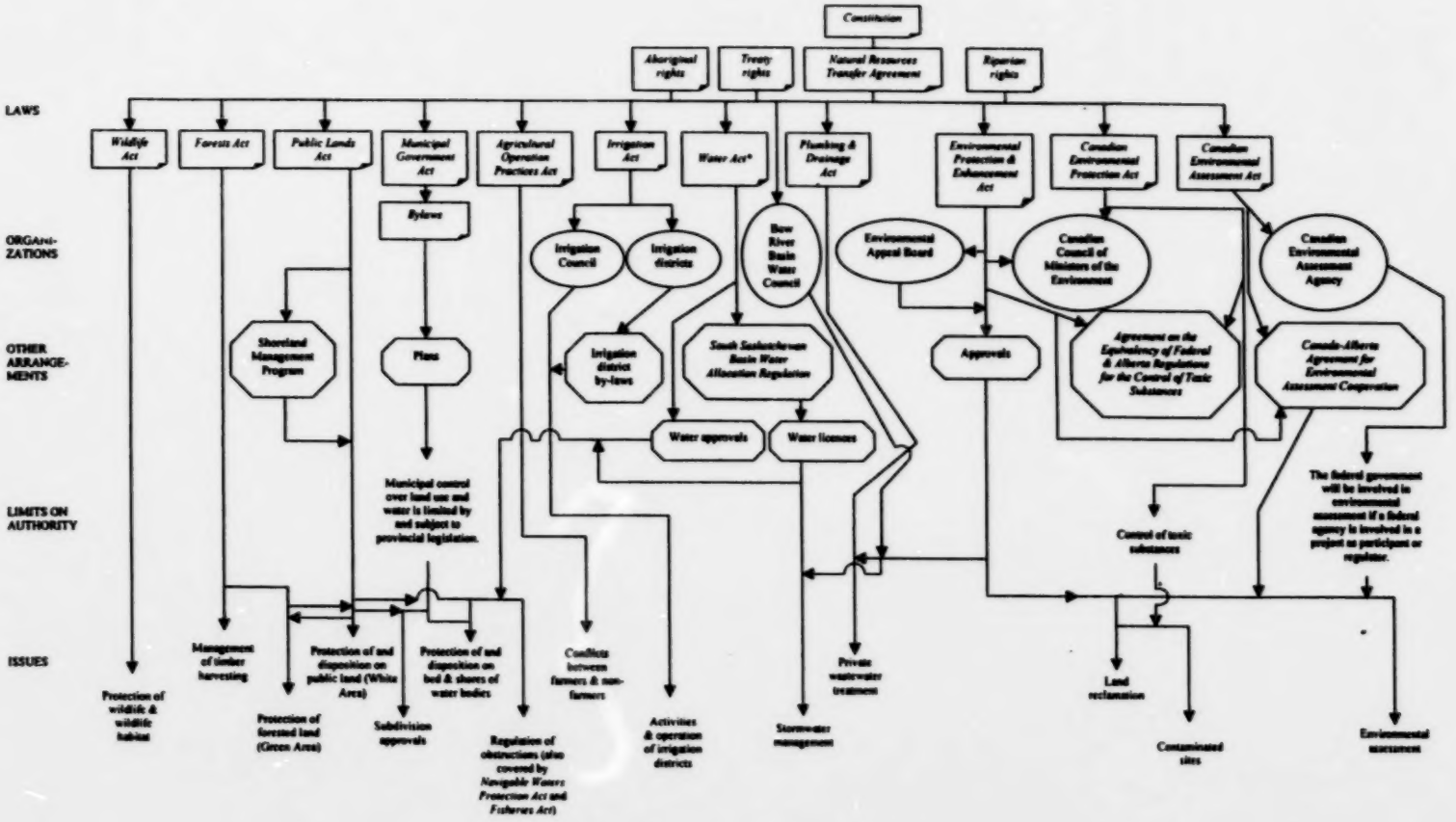


* On January 1, 1999, the *Water Act* replaced the *Water Resources Act*.

Figure C-3

Key Laws and Other Institutional Arrangements

LAND USE MANAGEMENT



* On January 1, 1999, the *Water Act* replaced the *Water Resources Act*

Table C-3
Implementation of Instream Objectives
Current Situation

Factor	Issue	Source of Concern	Responsible Agency or Body	Implementing Law, Program, Policy	Influence of IO
Flow	Reduced supply	Water withdrawals	♦ Federal government ♦ Provincial government ♦ City of Calgary	♦ *Fisheries Act* ♦ *Water Act* approvals (sole responsibility) ♦ City utility service extension policy	♦ Discretionary ♦ Approved water management plans must be considered
Flow	Reduced supply	Timber harvesting	♦ Provincial government	♦ *Forests Act*	♦ Discretionary
Water quality	Point-source discharge	Sewage effluent discharge	♦ Federal government ♦ Provincial government ♦ City of Calgary	♦ *Fisheries Act* ♦ *Environmental Protection and Enhancement Act* (EPEA) approvals (sole responsibility) ♦ City utility service extension policy	♦ Discretionary
Water quality	Point-source discharge	Stormwater management	♦ Federal government ♦ Provincial government ♦ Municipality (general) ♦ City of Calgary	♦ *Fisheries Act* ♦ EPEA approvals (sole responsibility) ♦ *Provincial Land Use Policies* ♦ Bylaws ♦ Development approvals ♦ City *Charter* (provincial statute)	♦ Discretionary
Water quality	Non-point pollution	Urban run-off	♦ Federal government ♦ Provincial government ♦ City of Calgary	♦ *Fisheries Act* ♦ EPEA: general application ♦ *Glenmore Park Bylaw* ♦ City *Charter* (provincial statute)	♦ Discretionary

Table C-3
Implementation of Instream Objectives
Current Situation

Water quality	Non-point pollution	Rural run-off	♦ Federal government ♦ Provincial government ♦ City of Calgary	♦ *Fisheries Act* ♦ Agricultural codes of practice (under review) ♦ Grazing permits in K-Country ♦ EPEA: general application ♦ City *Charter* (provincial statute)	♦ Discretionary
Water quality	Non-point pollution	Septic fields	♦ Federal government ♦ Provincial government ♦ City of Calgary	♦ *Fisheries Act* ♦ EPEA: general application ♦ *Plumbing Code Regulation* and *Private Sewage Disposal Systems Regulation* (*Safety Codes Act*) ♦ City utility service extension policy	♦ Discretionary
Water quality	Health	Specific contaminants	♦ Provincial government ♦ Health authority	♦ *Public Health Act* ♦ EPEA: general application ♦ Enforcement	♦ Discretionary
Flow & water quality	Land use impacts	Management of aquatic & riparian habitat	♦ Federal government ♦ Provincial government ♦ Municipality (general) ♦ City-MD Inter-Municipal Committee	♦ *Fisheries Act* ♦ *Water Act* ♦ *Public Lands Act* ♦ Other legislation ♦ Bylaws ♦ Development approvals	♦ Discretionary
Flow & water quality	Emerging issues	Various	♦ Bow River Basin Water Council ♦ Issue tracking by relevant agencies and groups		♦ Discretionary

Appendix C-2

Draft Terms of Reference
Elbow Watershed Committee

Draft Terms of Reference

Elbow Watershed Committee

1. MEMBERS

The members of the Committee would be those governments or agencies with responsibilities for regulating activities that could affect the river. This would include:

- Alberta Environment
- Alberta Agriculture, Food and Rural Development
- Alberta Labour
- City of Calgary
- Municipal District of Rocky View
- Tsuu T'ina Nation
- Townsite of Redwood Meadows
- Calgary Regional Health Authority

The Bow River Basin Water Council might also wish to have a member on the Committee.

2. PURPOSE

The purpose of the Committee would be to provide better monitoring and information, reduced risk, faster corrective response to water issues, increased public confidence, and greater consistency and reduced conflict among jurisdictions.

3. SCOPE

The Committee would address the following issues

a. protection of water quality in the Elbow River Basin
b. management of water quantity in the Elbow River Basin and
c. protection of aquatic and riparian habitat[1].

The Committee would have the authority to plan and coordinate the monitoring of flow and water quality in the Elbow River Basin, assess the results of monitoring, develop proposals for change, and promote greater awareness of water issues. The Committee would not be responsible for delivering the mandate or programs of member organizations

---

1 The Implementation Committee did not define "riparian habitat." The Water Quality Objectives Committee attempted to define "riparian habitat," but did not reach consensus on the issue. Three alternate definitions were identified:

- a definition based on vegetation, ground water, or other physical characteristics
- the 1-in-100 year floodplain
- the floodway as defined under the Canada-Alberta Flood Damage Reduction Program.

nor would these mandates or programs be delegated to the Committee.

The criteria for developing proposals for change would be:

a. risk to human health
b. potential to diminish, disrupt or damage water supplies
c. risk to the aquatic or riparian environment

4. ROLES AND RESPONSIBILITIES

- Monitoring
  - ensure that monitoring is consistent among jurisdictions
  - determine responsibility for data base maintenance
  - coordinate quality control for data
  - develop an annual monitoring work plan
  - facilitate public access to raw data.

- Review of Monitoring Results
  - based on monitoring, direct preparation of a periodic state of the river report
  - review the results from the state of the river report
  - develop proposals, as required, for implementation by the appropriate jurisdiction(s) in the areas of
    - remedial measures
    - policy change
    - regulatory change
    - changes in delivery of mandates and programs.

- Education
  - prepare and make available to member organizations, other agencies, and the public the results of the monitoring and the assessment of those results
  - increase public awareness of instream objectives, water issues, and the educational programs and materials that are available
  - provide rewards or awards for positive actions taken to protect or improve the Elbow River Basin.

The Bow River Basin Water Council would have the ability to change the roles and responsibilities of the Committee. Specific responsibility for activities such as the annual monitoring plan and public awareness would be jointly agreed to and co-ordinated by members of the Committee.

5. CONSULTATION

The Committee would meet annually or more frequently if required. The Committee would select a chairperson from among its members.

In the event of an emergency that adversely affects the quality or quantity of water within the watershed, the Committee, at the discretion of the chairperson, could be used as necessary to supplement and strengthen emergency actions and communication.

6. RESOURCE REQUIREMENTS

The anticipated resource requirements for the Elbow Watershed Committee are:

- Annual meeting/workshop — 3 days per participant
  (Average of 2 days preparation, 1-day meeting/workshop)
- Monitoring work plan — 3 days per year (total)
- Periodic state of the river report — 5 days per year (total)
- Public awareness — 5 days per year (total)

Resource requirements for monitoring, analysis, reporting results, data base maintenance, provision of public access, and quality control would be provided by the responsible agencies and others who have a stake in protecting the Elbow River Basin. It is expected that the work of the Elbow Watershed Committee would actually reduce resource requirements for these activities by making them more efficient and effective.

Appendix D

Fisheries Management Objectives for the Upper Elbow River

FISHERIES MANAGEMENT OBJECTIVES FOR THE UPPER ELBOW RIVER (Upstream of Glenmore Reservoir)

ISSUES:

What are the fisheries management objectives for the Upper Elbow River?

DISCUSSION:

Fisheries Management Objectives - Upper Elbow River

Maintenance of water quality standards and establishment of instream flow need amounts to maintain optimal levels of fish production.

Maintenance of an unobstructed channel above Glenmore Dam with adequate discharges to allow fish species unhindered movement upstream to spawn.

Maintenance of aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) to sustain fish production.

RESOURCE VALUES:

The Elbow River, upstream of Glenmore Dam, contains the following sportfish; mountain whitefish (*Prosopium williamsoni*), brook trout (*Salvelinus fontinalis*), bull trout (*Salvelinus confluentus*), and in lesser numbers cutthroat trout (*Oncorhynchus clarki*) and rainbow trout (*Oncorhynchus mykiss*). Mountain whitefish and rainbow trout are only found downstream of Elbow Falls. The seepage channels adjacent to the main stem of the Elbow are used for spawning by bull trout-a species of special concern- and brook trout. Mountain whitefish are known to spawn in the main stem of the Elbow. Bull trout are also known to spawn in the main stem downstream and upstream of Elbow Falls. Bull trout are present as far upstream as Enworthy Falls, located about 3 km downstream of Elbow Lake. A 2-4 km stretch of the Elbow River immediately upstream of its confluence with the Little Elbow River, goes dry after mid-summer. This creates a barrier for both upstream and downstream migration. Cutthroat trout are primarily found in the tributaries and rainbow trout are only sporadically found in the main stem. Rainbow trout found in the main stem would most likely be escapees from the stocked waterbodies adjacent to the Elbow (Allen Bill Pond, McLean Pond, Forgetmenot Pond).
The most obvious data gap is for the lower section of the Elbow River between Bragg Creek and the Glenmore Reservoir. Here we know we have mountain whitefish and brook trout but very little is know about the numbers and sizes of fish. We are also lacking information on what

other species of fish are present in this section and on their relative abundance and importance to the fishery. It is strongly recommended that a fisheries inventory be done as part of the proposed instream flow needs study.

Appendix E

Evaluation of Recent Trends in Water Quality
in the Elbow River
Upstream from Glenmore Reservoir

NOTE

This evaluation was originally provided to the Working Group in a June 9, 1998 memo. It was later revised and re-issued as a report. The report is provided in this appendix and is also available as a separate document.

The revised report includes analysis of total nitrogen that was not possible in 1998. The analysis indicates that there has been a significant decrease in total nitrogen in the river.

EVALUATION OF RECENT TRENDS IN WATER QUALITY IN THE ELBOW RIVER UPSTREAM FROM GLENMORE RESERVOIR

Prepared by:

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Limnologist

Water Sciences Branch
Water Management Division
Natural Resources Service

July, 1999

W9907

EXECUTIVE SUMMARY

Water Sciences Branch, Alberta Environment (AENV) was asked to determine if any significant changes had occurred in the water quality of the Elbow River upstream from Glenmore Reservoir, since the previous survey by the Alberta government (Beers and Sosiak 1993). All the available water quality data for the Glenmore Reservoir and the upper Elbow River were compiled and evaluated. Those variables with a sufficient number of samples were then tested statistically to determine whether significant changes in concentration had occurred over time.

This analysis found significant increases in total dissolved phosphorus, fecal coliforms, total coliforms and turbidity in the upper Elbow River at Highway 8 (Twin Bridges) since the previous basin-wide survey. Furthermore, water quality guidelines for the protection of aquatic life, irrigation and recreation were exceeded at the Twin Bridges site. Over the same time period, there was a significant decrease in total nitrogen and no significant change in the other variables that were tested for trends (flow, total phosphorus, chlorophyll *a*, total inorganic nitrogen, and total and dissolved organic carbon). Ongoing monitoring is necessary to confirm these trends.

There are insufficient data to determine the cause of increasing trends in the identified variables. Basin-wide sampling at locations sampled in 1988-90 should be repeated. Automated sampling of the Elbow River basin between Bragg Creek and Glenmore Reservoir was initiated in spring 1999 to enhance the existing database.

No evidence of adverse impacts on the Glenmore Reservoir was found.

ACKNOWLEDGEMENTS

I thank all technical and professional staff of Alberta Environment who have assisted in this analysis. Bridgette Halbig, Water Sciences Branch, AENV assisted in data compilation and report preparation. Jamie Dixon of the Waterworks Division provided water quality data from the City of Calgary. David Trew reviewed the manuscript and provided useful comments.

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1.0 INTRODUCTION

As part of the Bow Basin Plan, Water Sciences Branch, Alberta Environment (AENV) was asked to determine whether any significant changes had occurred in the water quality of the Elbow River upstream from Glenmore Reservoir, since the previous survey by the Alberta government in 1988-90 (Beers and Sosiak 1993). Beers and Sosiak (1993) found that water quality was generally good upstream from Calgary, except for increases in particulate matter during peak flow.

To determine whether water quality in the upper Elbow River has changed since 1988-90, all the available water quality data for the Glenmore Reservoir and the upper Elbow River were first compiled and evaluated. Variables with a sufficient number of samples were then compared to water quality guidelines and tested for monotonic trends, which are defined as gradual changes in concentration in one direction (i.e., over time).

2.0 ANALYTICAL METHODS

Water quality data collected by AENV and the City of Calgary at Twin Bridges (Highway 8 Bridge), Sarcee Bridge (in the former military range) (Figure 1) and lake composite data from the Glenmore Reservoir were compiled and evaluated statistically. Few samples were available from the Sarcee Bridge site after 1990. Accordingly, data from the Twin Bridges site were selected for trend analysis. Only data from the Glenmore Reservoir near the Weaselhead area were evaluated, as this location would be most influenced by inflow from the Elbow River.

In consultation with J. Dixon (Waterworks Division), all phosphorus data collected by the City of Calgary from the river sites in 1990-92 were deleted, due to concerns about the accuracy of these measurements. Ongoing duplicate analyses of split samples from Twin Bridges (1994-97) by Maxxam Analytics for AENV has generally confirmed that other data from the City of Calgary laboratory are of acceptable quality. Data from AENV (1979, 1988-90) and the City of Calgary (1982-83, 1989-97) were then merged, and paired with flow measurements from the Sarcee Bridge flow gauging station. To permit numerical analysis, values less than detection limits were replaced by values equivalent to one-half of the detection limit.

Variables with at least four years of data during 1979-97 were then compared to the Canadian and Alberta water quality guidelines (CCME 1999, AEP 1994) and tested for trends.

Variables were first tested with the Kruskal-Wallis test for seasonality. Variables exhibiting significant seasonality were tested for monotonic trends using the Seasonal Kendall Test, with (SKWC) or without (SKWOC) correction for significant serial correlation, using procedures in the computer program WQHYDRO (Aroner 1994). Data that did not display significant seasonal variation were tested for monotonic trends using the Mann-Kendall test. As recommended by Ward et al. (1990), a 0.10 level of statistical significance was used to assess the results of all tests.

3.0 RESULTS AND DISCUSSION

Significant trends were detected in four of the eight water quality variables tested for trends at the Elbow River at Twin Bridges. Significant increasing trends in the concentration of dissolved phosphorus, turbidity, fecal coliforms and total coliforms were detected at this site during at least part of the time period 1979-97 (Table 1). Except for dissolved phosphorus, for which there is no guideline, these variables also exceeded water quality guidelines for the protection of aquatic life, irrigation or recreation more often in recent years (Table 2, Figures 4, 6, 7). Although no significant trend in total phosphorus was detected, this variable has also exceeded the Alberta water quality guideline more frequently in recent years (Table 2).

These results suggest appreciable increases in these variables in the watershed upstream from Highway 8. In the nine years since the last basin-wide survey in 1988-90, the slope estimates for these trends indicate a 1.89 µg/L increase in dissolved phosphorus (0.21 µg/L per year) and 4.52 cells/100 mL increase in fecal coliforms. There were insufficient data to determine whether the phosphorus trend has resulted in an increase in periphytic algal biomass in the Elbow River.

No significant trends were detected in flow, total or dissolved organic carbon, total phosphorus or total inorganic nitrogen. There were insufficient data to test any of the other variables. Since there was no flow trend detected during 1979-97, there was no evidence that changing flow in the Elbow River caused any of the trends that were detected.

Although phosphorus levels have increased in the Elbow River, there is no evidence to date of increases in algal biomass, phosphorus or other variables in Glenmore Reservoir. Total nitrogen decreased in the reservoir composite samples collected near Weaselhead, and no trends were detected in the other variables that were tested (Table 1). This location appeared to provide the longest consistent record for the reservoir, and would most likely be affected by increased river

loading. However, insufficient turbidity and coliform data were available for testing from this reservoir site.

There are insufficient data to determine the cause of increasing trends in some constituents. However, potential sources are suggested by the significant seasonal variation that occurred in each constituent. Levels of dissolved phosphorus at Twin Bridges peaked in March (Figure 3), when snowmelt typically occurs in the foothills. This could reflect high nutrient loadings in spring runoff from livestock wintering areas, as documented elsewhere in Alberta. Fecal coliform levels at Twin Bridges peaked in May (Figure 5), before peak flows in June from mountain snow melt. This pattern could be caused by seepage from septic fields, following shallow ground water recharge. Turbidity levels at Twin Bridges peaked in June, which suggests channel erosion during high flows.

Ongoing sampling of the Twin Bridges site, with consistent sampling and analytical methods, is required to confirm the trends detected in this analysis. To determine the sources of these constituents will require more intensive sampling. Automated sampling of the Elbow River between Bragg Creek and the Glenmore Reservoir was initiated in spring 1999 to enhance the existing data base. Synoptic surveys of mainstem sites and all major tributaries during spring runoff could be used in the future to identify specific loading sources.

4.0 CONCLUSIONS AND RECOMMENDATIONS

1. Levels of dissolved phosphorus, fecal coliforms, total coliforms and turbidity have increased in the Elbow River upstream from Glenmore Reservoir since the previous basin-wide survey. However, this analysis found no evidence of adverse impacts on the Glenmore Reservoir. Ongoing monitoring is necessary to confirm these trends.
2. There are insufficient data to determine the cause of increasing trends in these variables. Basin wide sampling at locations sampled in 1988-90 should be repeated. Automated sampling of the Elbow River basin between Bragg Creek and Glenmore Reservoir was initiated in spring 1999 to enhance the existing data base.

5.0 LITERATURE CITED

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Table 1. Significant monotonic trends (slopes in bold font) in biological and chemical variables in the Elbow River at Twin Bridges. Sampling periods for each variable are in parentheses.

Sen Slope (Units/Year) for Significant Trends (Seasonal Kendal Tau Test)					
SITES	VARIABLES				
	Flow m^3/s	Turbidity JTU/NTU	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Total Nitrogen µg/L
Elbow R. at Twin Bridges	NS[a] (79-97)	**+0.054** (79-97)	NS (82-97)	**+0.21** (88-97)	**-16.84** (82-97)
	Total Inorganic Nitrogen mg/L	Total Organic Carbon mg/L	Dissolved Organic Carbon mg/L	Fecal Coliforms No./100 mL	Total Coliforms No./100 mL
Elbow R. at Twin Bridges	NS (82-97)	NS (79-97)	NS (83-97)	**+0.502** (79-97)	**+4.444** (79-97)
	Total Phosphorus µg/L	Total Dissolved Phosphorus µg/L	Total Nitrogen µg/L	Total Inorganic Nitrogen µg/L	Phytoplankton Chlorophyll *a* µg/L
Glenmore Reservoir near Weaselhead	NS (1982-97)	NS (1993-97)	**-8.10** (82-97)	NS (82-97)	NS (1982-97)

[a]NS: Not Statistically Significant

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[a]NS: Not Statistically Significant

Table 2. Number of samples that exceeded water quality guidelines each year in the Elbow River at Twin Bridges, 1979-97. None of the nitrite[h], nitrite+nitrate[i] or ammonia[j] samples exceeded water quality guidelines.

	Total Phosphorus		Total Nitrogen		Turbidity			Total Coliforms		Fecal Coliforms		
	n[k]	no. >GL	*n*	no. >GL	*n*	no. >GL	no. >GL	*n*	no. >GL	*n*	no. >GL	no. >GL
Guideline:		0.05 mg/L[a]		1.0 mg/L[b]		22 NTU[c]	25 NTU[d]		1000 cells/ 100 mL[e]		100 cells/ 100 mL[f]	400 cells/ 100 mL[g]
1979	24	1	0	0	23	0	0	23	0	23	0	0
1982	5	0	5	0	0	0	0	5	0	5	0	0
1983	8	1	10	0	0	0	0	10	0	10	1	0
1988	11	0	0	0	12	1	1	12	0	12	0	0
1989	4	0	0	0	11	0	0	21	0	22	0	0
1990	2	1	0	0	6	1	1	14	0	10	0	0
1991	0	0	0	0	11	2	2	15	0	14	0	0
1992	0	0	1	0	11	2	2	35	0	33	1	0
1993	7	3	0	0	0	0	0	0	0	0	0	0
1994	37	1	8	0	10	0	0	0	0	34	1	0
1995	51	6	12	1	13	3	3	0	0	38	3	0
1996	49	3	13	0	12	0	0	32	1	44	1	0
1997	41	1	11	0	13	1	1	44	4	44	1	1

[a] Alberta Ambient Surface Water Quality Interim Guideline (1994)

[b] Alberta Ambient Surface Water Quality Interim Guideline (1994)

[c] CCME (1992, cited in CCME 1999) guideline for recreational water quality and aesthetics: increase of 5 NTU over background, here defined as the maximum concentration in 1979 (17 mg/L)

[d] CCME (1999) guideline for the protection of aquatic life: increase of 8 NTU over background, here defined as the maximum concentration in 1979 (17 mg/L)

[e] CCME (1987, cited in CCME 1999) guideline for the protection of agricultural uses (irrigation)

[f] CCME (1987) guideline for the protection of agricultural uses (irrigation)

[g] CCME (1987) guideline for recreational water quality and aesthetics: resample when any sample >400 cells/ 100 mL

[h] CCME (1987) guideline for the protection of aquatic life (0.06 mg/L nitrite as N)

[i] CCME (1987) guideline for drinking water quality (10.0 mg/L nitrite+nitrate as N)

[j] most stringent CCME (1987) guideline for the protection of aquatic life for the range of pH and temperature likely to occur at this site (1.33 mg/L total ammonia)

[k] sample size

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	n[k]	no. >GL	*n*	no. >GL	*n*	no. >GL	no. >GL	*n*	no. >GL	*n*	no. >GL	no. >GL
Guideline		0.05 mg/L[a]		1.0 mg/L[b]		22 NTU[c]	25 NTU[d]		1000 cells/ 100 mL[e]		100 cells/ 100 mL[f]	400 cells/ 100 mL[g]
1979	24	1	0	0	23	0	0	23	0	23	0	0
1982	5	0	5	0	0	0	0	5	0	5	0	0
1983	8	1	10	0	0	0	0	10	0	10	1	0
1988	11	0	0	0	12	1	1	12	0	12	0	0
1989	4	0	0	0	11	0	0	21	0	22	0	0
1990	2	1	0	0	6	1	1	14	0	10	0	0
1991	0	0	0	0	11	2	2	15	0	14	0	0
1992	0	0	1	0	11	2	2	35	0	33	1	0
1993	7	3	0	0	0	0	0	0	0	0	0	0
1994	37	1	8	0	10	0	0	0	0	34	1	0
1995	51	6	12	1	13	3	3	0	0	38	3	0
1996	49	3	13	0	12	0	0	32	1	44	1	0
1997	41	1	11	0	13	1	1	44	4	44	1	1

[a] Alberta Ambient Surface Water Quality Interim Guideline (1994)
[b] Alberta Ambient Surface Water Quality Interim Guideline (1994)
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[h] CCME (1987) guideline for the protection of aquatic life (0.06 mg/L nitrite as N)
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[j] most stringent CCME (1987) guideline for the protection of aquatic life for the range of pH and temperature likely to occur at this site (1.33 mg/L total ammonia)
[k] sample size

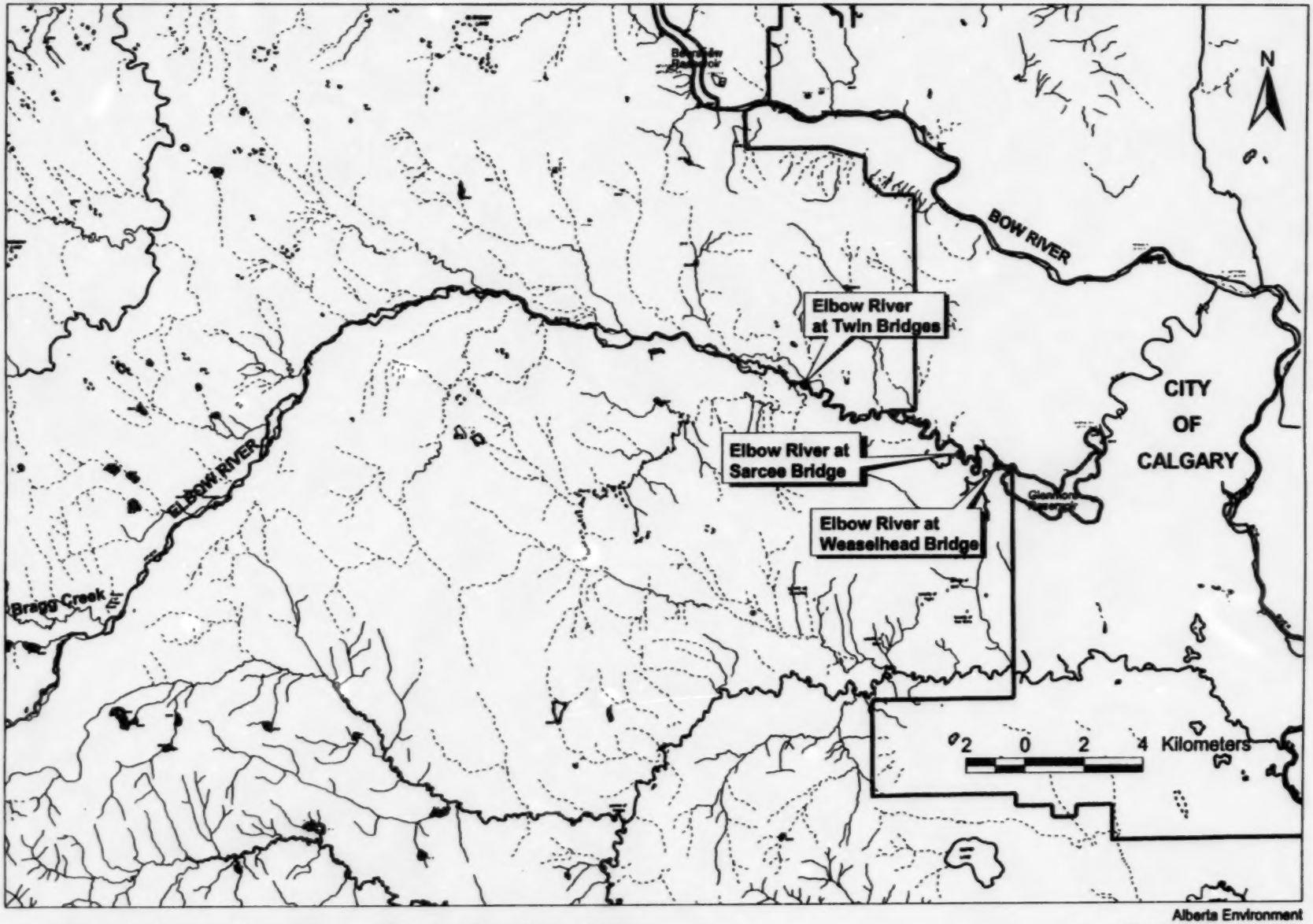

Figure 1. Elbow River water quality sampling site locations.

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Water Management Division

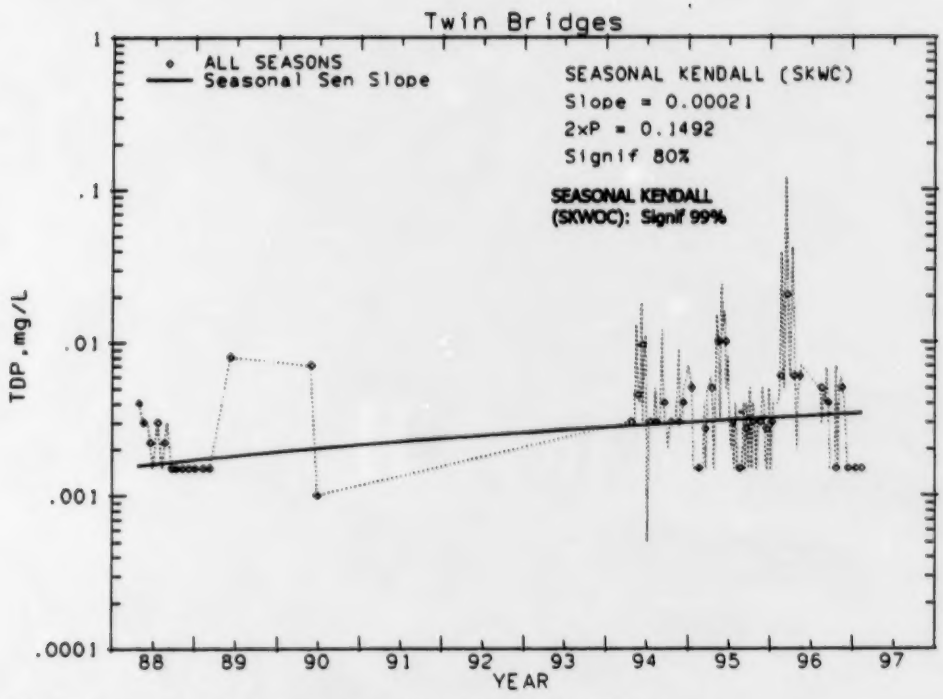

Figure 2. Dissolved phosphorus at Twin Bridges, 1988-97.

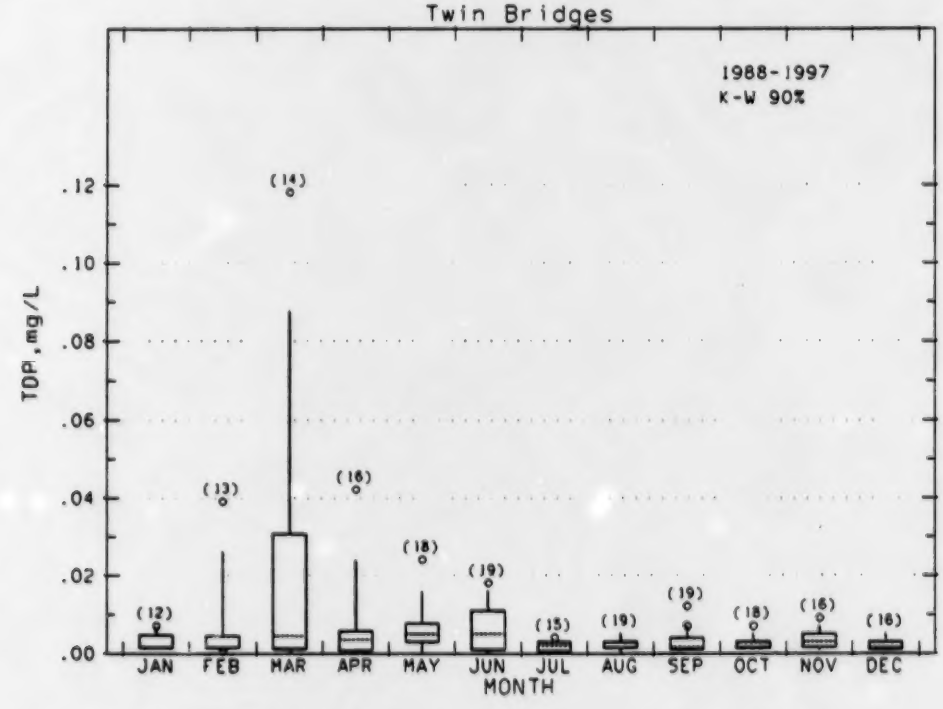

Figure 3. Seasonal variation in dissolved phosphorus. (n) = number of samples.

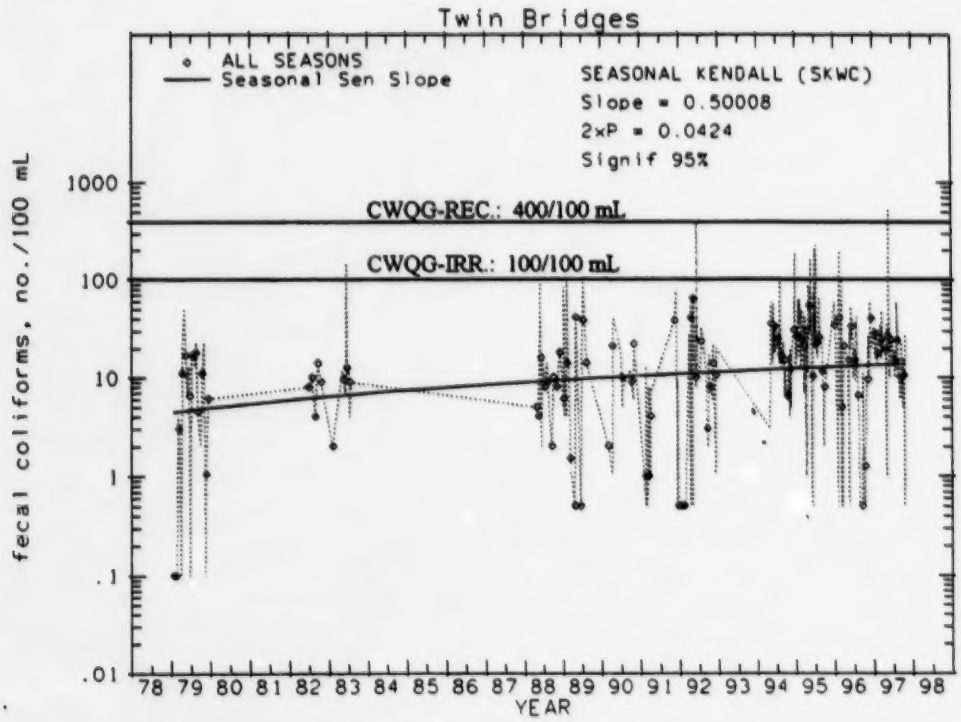

Figure 4. Fecal coliforms at Twin Bridges, 1979-97.

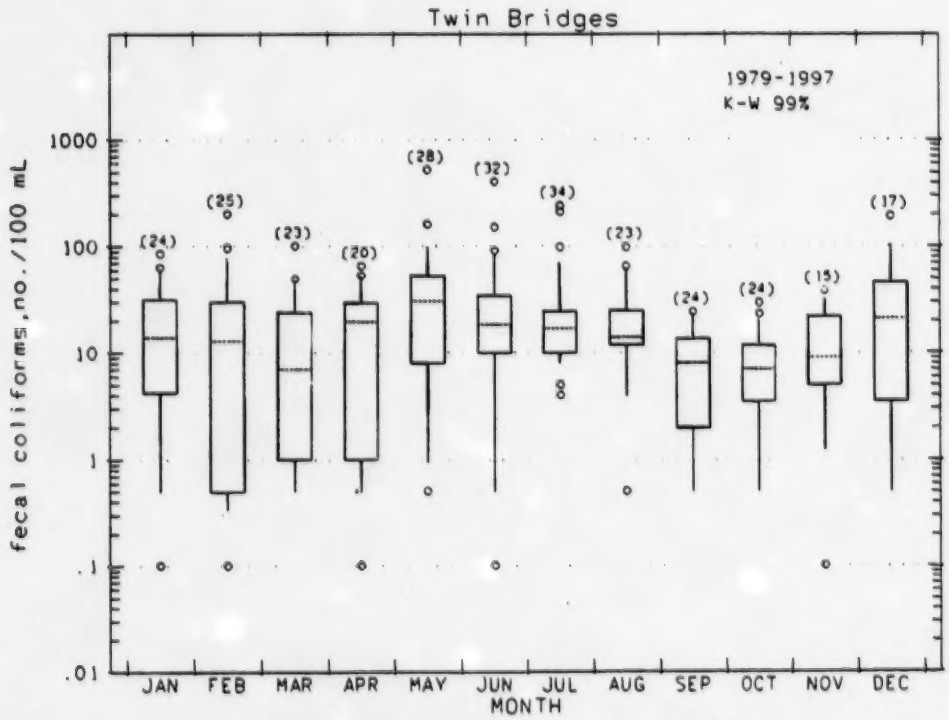

Figure 5. Seasonal variation in fecal coliforms. (n) = number of samples.

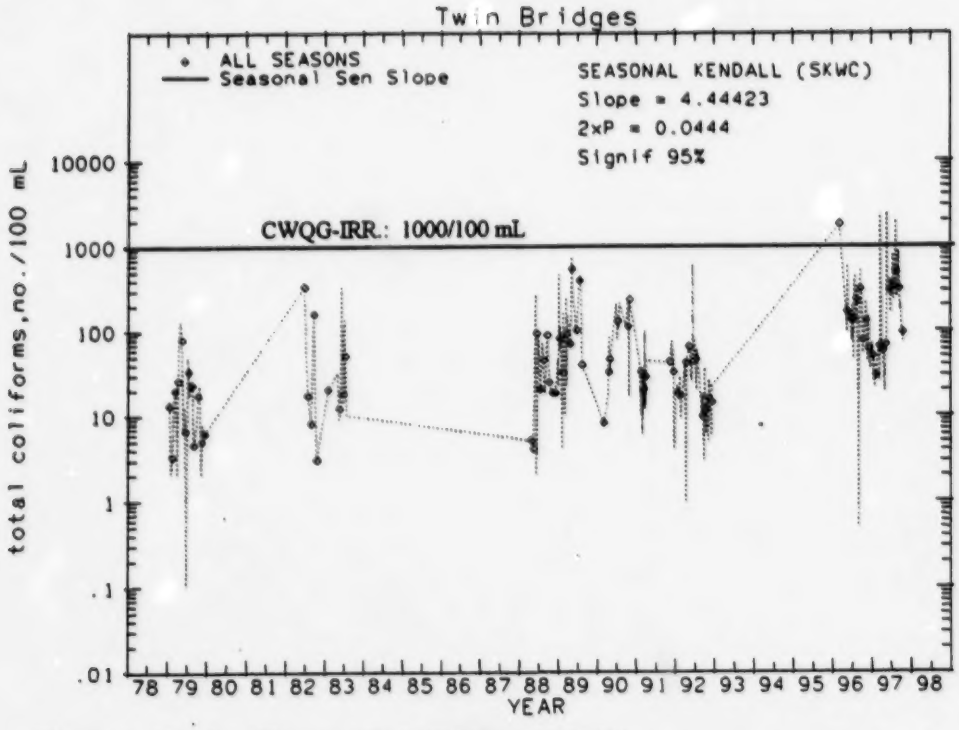

Figure 6. Total coliforms at Twin Bridges, 1979-97.

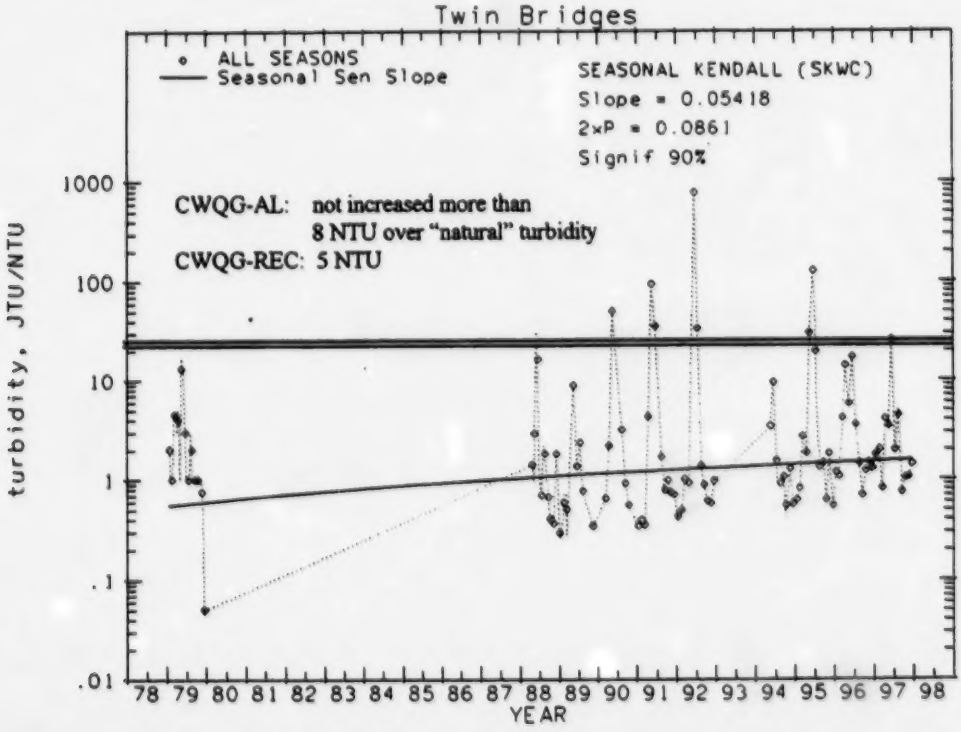

Figure 7. Turbidity at Twin Bridges, 1979-97 (JTU: 79-80; NTU: 88-97).

Appendix E-1
(not an appendix to the *Evaluation of Recent Trends...*)

Criteria for Trend Analysis

- Non-parametric statistics (which are not based on assumptions about the distribution of the data) were used in the trend analysis because parametric methods require rigorous testing of assumptions and may be adversely affected by certain other factors.

- Non-parametric methods do not require a continuous record and are statistically valid even with data gaps, which are usually found in water quality monitoring records.

- The analysis took into account both seasonality and flow.

- The time periods 1979-1997 and 1988-1997 were analyzed for trends in flow and no significant trend was detected. The 1982-1997 period was not analyzed for trends in flow.

- No variable was considered for trend analysis unless at least four years of data were available. The data did not have to be continuous.

- Questionable data were deleted from the data base. This included data on phosphorus for 1990-92.

- A trend was considered significant only if it had a less than 10% probability of being due to chance. This is standard procedure for water quality trend analysis. A 5% probability level was not used because it would substantially increase the risk of a Type II error (in this case, failure to detect a genuine trend). The level of significance was selected before the analysis began.

- If the two forms of the Seasonal Kendall trend test (with and without correction for serial correlation) did not give identical results, the individual data set was tested for serial correlation using the Kendall tau, Spearman rho and Normal tests. The appropriate Seasonal Kendall trend test result was then selected.

- The Sen slope analysis shows the relative magnitude of change. It describes what has happened and should not be used to predict future conditions.

- Fecal coliform was used in the trend analysis because it is a good indicator of contamination that is a threat to human health. The preference is to use *E. coli*, but there was not a sufficiently long data set for *E. coli*. Total coliform was included because the City of Calgary uses it as an indicator of the quality of its water supply.

- Dissolved phosphorus and total phosphorus were used because both are indicators of nutrient enrichment. Dissolved phosphorus is the preferred indicator because it directly influences algal growth.

- Changes in sampling frequency did not adversely affect the analysis. Each month was analyzed separately and only the monthly averages were included in the analysis.

Appendix F

Data on Instream Flow Needs Methods, Natural Flow, Withdrawal Licences, Effluent Discharge Approvals, and Flow Requirements for Instream Needs

Instream Flow Needs Methods

In addition to the water quality requirements identified in Appendix B, it was necessary to determine the amount of flow required to protect instream needs.

The Working Group identified four types of instream needs that should be considered in the upper Elbow River Basin:

- fish habitat
- river recreation
- ecosystem protection
- downstream uses.

For fish habitat, river recreation, and ecosystem protection, various methods of estimating flow requirements have been developed. These methods and their strengths and weaknesses are summarized in Table F-1.

For downstream uses, flow requirements are usually estimated using data from licences. Other downstream uses such as domestic and stockwatering are small and adequately protected by the flow needed to meet other requirements.

The Working Group decided to use the following approach for developing flow requirements for instream needs:

Instream Need	Method
Fish Habitat	• Develop flows for fish habitat using the Tennant-Tessman Method.
River Recreation	• Use canoeing as an indicator for river recreation. • Develop flows for canoeing using data collected by the Bow Waters Canoe Club.
Ecosystem Protection	• Use fish habitat as an indicator for ecosystem health.
Needs of Downstream Users	• Use data on licensed uses.

Table F-1
Comparison of Selected Instream Needs Methods

Instream Needs Method	Data & Expertise Requirements	Pros	Cons
Fish Habitat Tennant (Montana) Method	• Naturalized flow • Expert judgement	• Quick • Inexpensive • Good for feasibility studies • Requires moderate field expertise • Predicts habitat quality & impact of changes in flow	• Crude • Only uses two periods of year: Oct.-Mar. & Apr.-Sept. • Provides constant flow • Low flushing flow requirements • Does not cover water quality
Fish Habitat Tennant-Tessman Method	• Naturalized flow • Expert judgement	• Quick • Inexpensive • Good for feasibility studies • Requires moderate field expertise • Uses monthly time periods	• Crude • Does not predict habitat quality & impact of changes in flow • Provides constant flow • Low flushing flow requirements • Does not cover water quality
Fish Habitat R-2 Cross (Colorado) Method	• Hydrology data • Cross-section data • Expert judgement	• Ties flow to hydraulic conditions • Predicts habitat quality & impact of changes in flow	• Requires field work • Does not work well in non-wadable streams • Subject to error in Manning's "n" at max. & min. discharge • Does not cover water quality
Fish Habitat Water Surface Profile Method	• Hydrology data • Cross-section data • Expert judgement	• More sophisticated than R-2 Cross Method • Predicts habitat quality & impact of changes in flow • Considers sediment transport if required	• Does not incorporate species habitat criteria • May result in critically low habitat • Specific use for small salmonid streams • Requires field work • Expensive • Does not cover water quality
Fish Habitat Thompson (Oregon) Method	• Hydrology data • Species composition & temporal use patterns • Habitat criteria for weighting factors • Cross-section data • Expert biologist for transect placement & habitat quality judgements	• Specific use for salmonids • Powerful method for specific season & habitat criteria • Can incorporate usability weighting factors • Best suited for streams with relatively uniform morphology	• No hydraulic modelling • High labor cost • In absence of data, requires subjective assessment of habitat quality & utilization • Only considers substrate, depth, & velocity • Limited flexibility in analysis (extrapolation, interpolation) • More than three stage measurements required for streams with irregular habitat/flow relationship • Does not cover water quality

Table F-1
Comparison of Selected Instream Needs Methods (cont.)

Instream Needs Method	Data & Expertise Requirements	Pros	Cons
Fish Habitat Instream Flow Incremental Methodology	• Multiple cross-section data • Substantial hydrology record • Accurate species composition & distribution data • Accurate habitat preference criteria • Expert biologist to select reaches & transects	• Predicts habitat quality & impact of changes in flow • Superior definition of habitat/flow relationship • Powerful tool • Widely recognized • Quantifies wetted area in terms of its usability as habitat • Good for smaller streams	• Must be calibrated to individual stream hydraulics • High labor and analysis cost • Requires computer expertise for analysis • Not designed to determine IN for natural systems • Gives equal weight to each habitat parameter • Requires judgement on depth & velocity calculations • Concerns about applicability to larger, prairie streams • Does not cover water quality
River Recreation Hyra Method	• Hydrology data • Depth & velocity data	• Quick • Inexpensive • Good for feasibility studies • Provides min., max., & optimum values • Best suited for streams with relatively uniform morphology	• Crude • No criteria for kayaking • No differentiation of skill level • Does not consider recreational importance of stream/reach • Does not cover water quality or aesthetics
River Recreation Expert Method I - focus group	• Hydrology data • Experienced recreationists	• Inexpensive • Considers actual use of stream/reach • Considers recreational importance of stream/reach • Considers different skill levels • Considers differences in stream morphology	• Crude • Very dependent on knowledge & experience of recreationists • Relies on memory of recreationist • Can be very site-specific • Does not work well for streams where access is limited • Does not work for water quality or aesthetics
River Recreation Expert Method II – field tests	• Ability to manipulate flows or several visits to river at different flows • Experienced recreationists	• Inexpensive • More accurate • Considers actual use of stream/reach • Considers differences in stream morphology	• Can be time-consuming • Very dependent on experience of recreationists • Low sample size • Possible biases or gamesmanship
River Recreation Club Record Method	• Hydrology data • Extensive, reliable records kept by recreation club	• Quick • Inexpensive • Considers actual use of stream/reach • Considers recreational importance of stream/reach • Considers different skill levels	• Crude • Very dependent on quality of club records • Relies on memory of recreationist • Can be very site-specific • Does not work well for streams where access is limited • Does not work for water quality or aesthetics

Table F-1 Comparison of Selected Instream Needs Methods (cont.)			
Instream Needs Method	**Data & Expertise Requirements**	**Pros**	**Cons**
River Recreation Surveys	• Hydrology data • Recreation expert(s) to select sites & design questionnaire	• Mail surveys can be relatively inexpensive • Provides higher quality information • Considers actual use of stream/reach, particularly on-site surveys • Considers recreational importance of stream/reach • Considers different skill levels • Can be used for water quality and aesthetics	• More expensive, particularly for telephone & on-site surveys • Mail surveys have low return rate & poor quality control • Telephone and, often, mail surveys rely on memory of respondent • Time-consuming for respondents • Difficult & expensive to apply to streams where access is limited
Ecosystem Protection Index of Biotic Integrity	• Considerable data and resource requirements. Depends on ecosystem being studied.	• Looks at a community of animals, not just one or two	• Expensive • Very data and labor intensive • No track record that it protects the ecosystem better than other approaches
Ecosystem Protection Fish as Indicator Species	• Depends on method selected for analyzing fish habitat requirements. (See above.)	• Simpler, less expensive • Assumes that, since fish are high in the food chain, if the fish are protected then other species will also be protected	• Emphasizes sport fish • May miss vital link(s) in the food chain
Ecosystem Protection Hydraulic Diversity Analysis	• Hydrology data • Hydraulic data • Engineering expertise	• Considers differences in stream morphology	• Expensive data collection
Ecosystem Protection Video or Airphoto Methods	• Video or airphotos • Hydrology data • Ecological expertise	• Looks at a community of animals, not just one or two • Considers differences in stream morphology • Visual, good for eliciting "local knowledge"	• Expensive • Technology in its infancy. No track record that it protects the ecosystem better than other approaches • May not be sensitive to small differences in flows • Does not apply to water quality

Sources:

Kasey Clipperton, *Instream Flow Needs for Water-Based Recreation on the Bow River*, Alberta Environmental Protection, 1997.

D. A. Fernet, *A Comparison of the Weighted Usable Width, Modified Tennant, and Instream Flow Incremental Methodology Analyses of Instream Flow Needs in Pekisko Creek*, Alberta Forestry, Lands and Wildlife, 1987.

Hatfield Consultants and Charles Howard & Associates, *An Evaluation for Use in Alberta of Instream Flow Needs Assessment Methodologies Developed in the Northwest United States*, Alberta Environment, 1983.

Natural Flow

"Natural flow" is the amount of water that would naturally be available in a river or stream if there had been no diversions of water by people. Natural flow is calculated by adding significant withdrawals to the recorded flow in the river and by subtracting any significant augmentation of the flow. For the Elbow River, only the City of Calgary's use of water was considered significant enough to include in the calculation of natural flow. The use of water by other users was not included. As a result, the estimates of natural flow are slightly different (usually lower) than what natural flow actually was.

Natural flow in the Elbow River below Glenmore Reservoir provides the best estimate of total natural flow in the upper Elbow. It ranges from just under 110,000 acre feet per year to over half a million acre feet per year. Average natural flow is around 240,000 acre feet per year.

Natural flow in the upper Elbow River varies considerably during the year and from year to year (Figure F-1). The highest flows occur in the late spring and early summer. The lowest flows occur during the winter. Low flows can also occur during other seasons of the year. During dry years such as occurred in 1936 and 1984, there can be extended periods of low flow during the spring, summer, and fall.

Withdrawal Licences

There are over 130 surface and ground water withdrawal licences that have been issued in the upper Elbow River Basin (Table F-2). Total licensed withdrawal is slightly less than 104,000 acre feet, of which 88,000 acre feet (85%) have been allocated to the City of Calgary at Glenmore Reservoir. Total licensed withdrawal is 43% of average annual natural flow and almost equal to the natural flow available during the driest year on record.

The probability[1] of licensees being able to withdraw water varies considerably during the year (Figure F-2). From May through October, there is generally a 90% or greater probability that natural flow will be able to provide all the water that water users need. During the winter and early spring, there is less chance that natural flow will be adequate to meet water users' needs.

Under current winter conditions with the City of Calgary being the dominant water user, the probability of receiving an adequate supply from natural flow is in the 50% to 70% range. However, the probability of receiving an adequate supply drops to between 10% and 30% if, through transfers or changes in operations, other users are able to maximize diversions[2] during the winter. This indicates that the risk of water shortages will increase significantly if additional water use is allowed during the winter.

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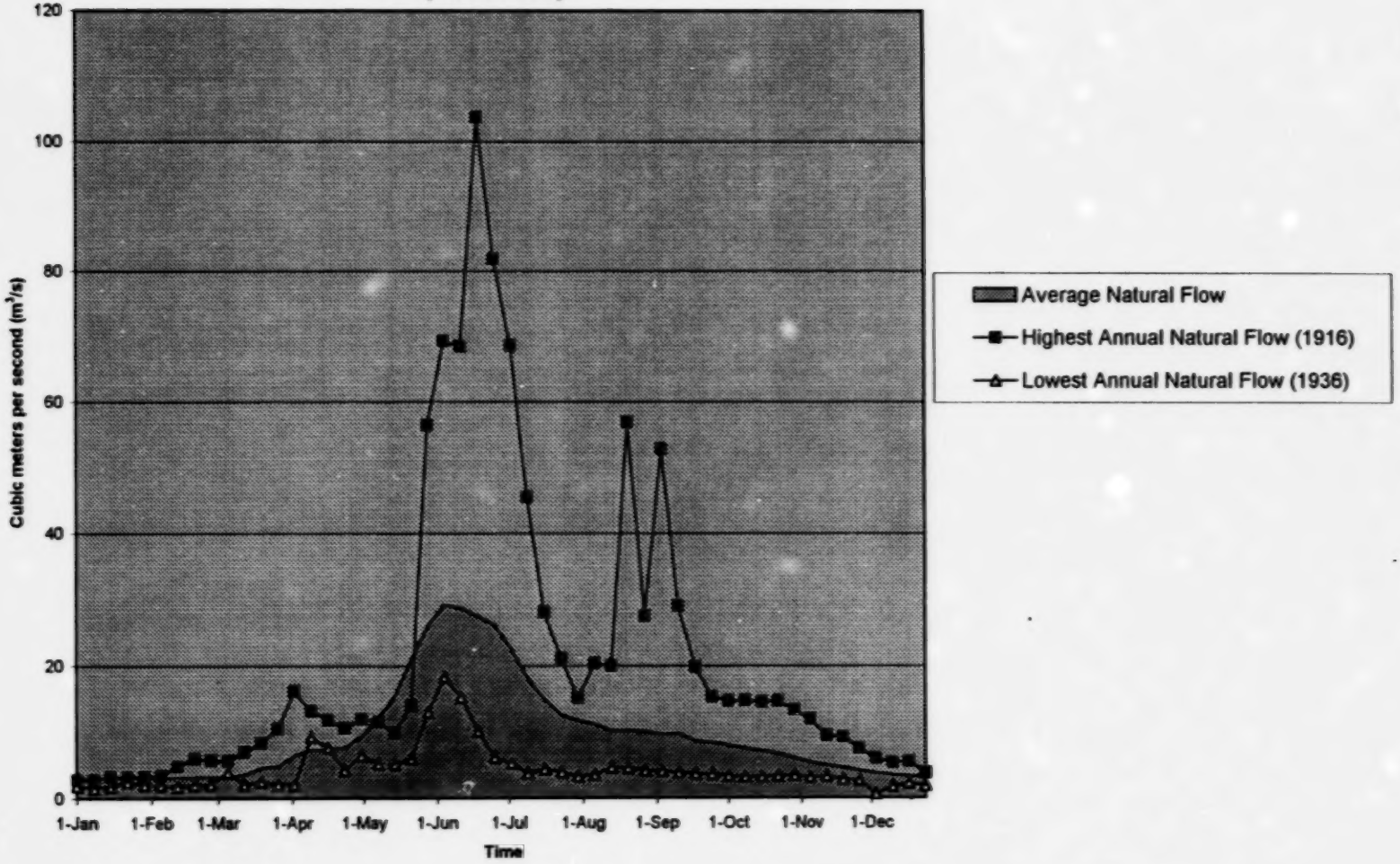
1 Probability, as used here, is the percentage of years that enough water would be available in the river to meet demand. It was calculated by comparing water demand to the natural flow that has occurred during each week.

2 Maximum diversion was calculated by adding the City of Calgary's historical average demand to the diversion rates prescribed in other licences.

Figure F-1

Elbow River Below Glenmore Reservoir
Natural Flow
(1912-1988)



Probability of Flow in the River
Being Sufficient to Meet Existing Demand
Upper Elbow River

Figure F-2

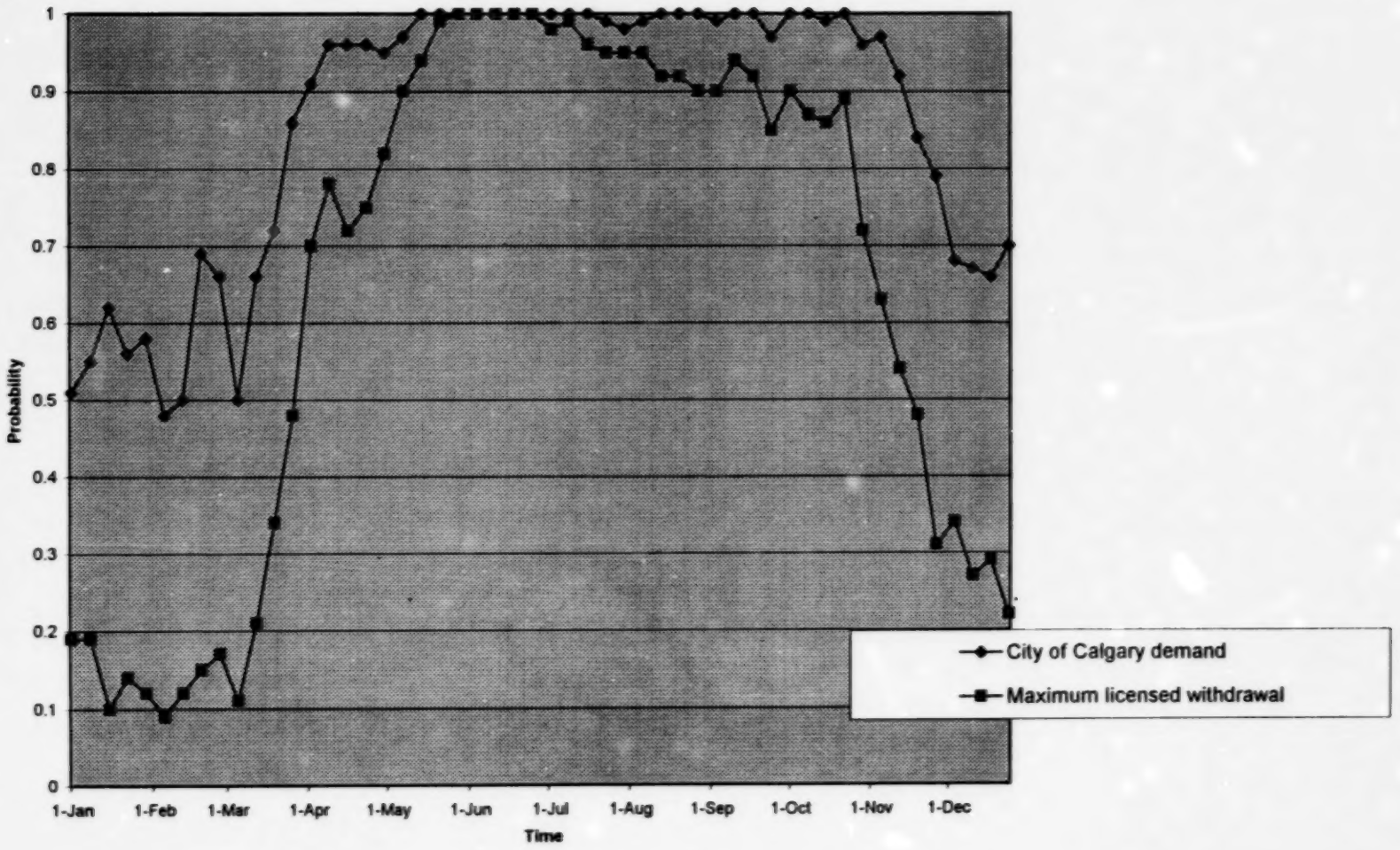


Table F-2
SUMMARY OF ELBOW RIVER LICENCES
(as of May 1, 1999)

GROUND WATER

By Purpose

	Number of Licences	Annual Quantity (acre feet)	Maximum Rate of Diversion (cubic feet per second)	Storage (acre feet)
Agricultural	28	69.5	0.7	0.0
Domestic	6	29.0	0.1	0.0
Industrial	1	4.0	0.0	0.0
Municipal	19	115.5	1.4	0.0
Other	9	211.8	0.6	0.0
Totals	63	429.8	2.8	0.0

SURFACE WATER

By Purpose

	Number of Licences	Annual Quantity (acre feet)	Maximum Rate of Diversion (cubic feet per second)	Storage (acre feet)
Agricultural	20	1,292.0	0.0	168.8
Diversion	7	0.0	0.0	0.0
Domestic	3	10.0	0.1	0.0
Industrial	0	0.0	0.0	0.0
Irrigation	5	800.0	1.9	22.0
Municipal				
City of Calgary	2	88,000.0	450.0	35,811.0
Others	11	936.4	5.4	1.5
Storage	11	9,748.0	13.4	403.0
Other	15	2,753.0	16.6	406.7
Totals	74	103,539.4	487.4	36,813.1

By Water Body

	Number of Licences	Annual Quantity (acre feet)	Maximum Rate of Diversion (cubic feet per second)	Storage (acre feet)
Bragg Creek	2	3.0	0.3	0.3
Cullen Creek	2	57.0	0.8	4.8
Elbow River				
City of Calgary	2	88,000.0	450.0	35,811.0
Others	33	5,360.4	20.8	297.5
Ford Creek	1	0.0	0.0	0.0
Iron Creek	2	62.0	0.0	105.5
Lott Creek	2	9,680.0	13.4	0.0
McLean Creek	1	3.0	0.0	95.0
Springbank Creek	2	14.0	0.0	50.7
Spring Creek	1	3.0	0.0	3.2
Other - coulees, creeks, sloughs, springs, surface run-off	26	357.0	2.1	445.2
Totals	74	103,539.4	487.4	36,813.1

Effluent Discharge Approvals

Six effluent discharge approvals have been issued in the upper Elbow River Basin for municipal wastewater treatment (Table F-3). None of these wastewater treatment facilities discharge effluent directly to the Elbow River or other water bodies.

Flow Requirements for Instream Needs

Fish Habitat[3]

The Elbow River upstream of Glenmore Reservoir contains the following sportfish: mountain whitefish, brook trout, bull trout, and, in lesser numbers, cutthroat trout and rainbow trout. Mountain whitefish and rainbow trout are only found downstream of Elbow Falls. Bull trout are present as far upstream as Edworthy Falls, located about 3 km downstream of Elbow Lake.

The seepage channels adjacent to the main stem of the Elbow River are used for spawning by bull trout – a species of special concern – and brook trout. Mountain whitefish are known to spawn in the main stem of the Elbow. Bull trout are also known to spawn in the main stem downstream and upstream of Elbow Falls.

A 2 to 4 km stretch of the Elbow River immediately upstream of its confluence with the Little Elbow River goes dry after mid-summer. This creates a barrier for both upstream and downstream migration. Cutthroat trout are primarily found in the tributaries and rainbow trout are only sporadically found in the main stem. Rainbow trout found in the main stem would most likely be escapees from the stocked water bodies adjacent to the Elbow (Allen Bill Pond, McLean Pond, Forgetmenot Pond).

The most obvious data gap is for the lower section of the Elbow River between Bragg Creek and Glenmore Reservoir. Mountain whitefish and brook trout are known to be present in that reach, but very little is known about the numbers and sizes of fish. Information is also lacking on what other species of fish are present downstream of Bragg Creek and on their relative abundance and importance to the fishery. It is strongly recommended by Alberta Environment that a fisheries inventory be done.

It is also not known to what extent fish habitat and fish populations in the Elbow River above Glenmore Reservoir have been impacted by human activities or the extent to which the fishery could be enhanced. As a result, the potential for restoring or improving fish habitat and fish populations is not known.

Estimates of the flow required to protect fish habitat in the upper Elbow River were developed using the Tennant-Tessman method. This method was developed in the United States between 1964 and 1980. It is a quick and relatively inexpensive technique based solely on the hydrology of the stream.

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[3] Work beginning in the summer of 1999 will provide better information on the fish habitat in the Elbow River and the flow and other factors needed to maintain that habitat.

Table F-3
SUMMARY OF UPPER ELBOW RIVER MUNICIPAL WASTEWATER TREATMENT WITH PROVINCIAL APPROVALS

Project	Treatment	Discharge
Calaway Park	Wastewater lagoons: one facultative, one storage cell	Wastewater irrigation on adjacent properties
Elbow Valley / Pinebrook Wastewater Pipeline	Wastewater pipeline to the City of Calgary. No treatment or storage facilities.	
Elbow Valley Development	Wastewater collection system	Connected to wastewater pipeline to the City of Calgary.
Pinebrook Estates (Power Farms)	Wastewater collection system	Connected to wastewater pipeline to the City of Calgary.
Elbow Valley Elementary School, Springbank Elementary School, and Springbank Community High School	Wastewater lagoons: two facultative cells, one storage cell	Wastewater irrigation on schoolyard property during summer months
Wintergreen Family Resorts	Extended aeration package treatment plant (mechanical)	Wastewater irrigation on Wintergreen Golf Course

The Tennant-Tessman method has been adopted by Alberta Environment as the standard planning tool for calculating instream flow recommendations when site-specific data has not been collected. Alberta Environment has modified the Tennant-Tessman method to produce weekly rather than monthly estimates of the flow required for fish habitat. Alberta Environment applies the results of the Tennant-Tessman method to conditions in licences when site-specific information is not available.

The Tennant-Tessman flow recommendations for the upper Elbow River are shown in Figure F-3. It should be noted that if natural flow is less than what is shown in Figure F-3, then the fish habitat requirement will be equal to natural flow.

River Recreation[4]

There are a variety of river craft used on the Elbow River including kayaks, innertubes, and rafts. Each type of craft has different flow requirements. The flow required for canoeing was used to represent the instream needs for river recreation. Canoeing is among the most popular recreational activities on the upper Elbow River. There is also a fair amount of information on canoeing that can be related to flow in the river. If flows are protected for canoeing, then it is expected that the flow will also be satisfactory for other forms of river recreation, including non-paddling recreation such as swimming.

Upstream of Bragg Creek, the paddling is better and the recreational use of the river is higher. All reaches of the Elbow River below the confluence with the Little Elbow River down to Bragg Creek is used for paddling but the most important section is from Canyon Creek to Allen Bill Pond (most popular for kayaking and intermediate canoeing). The Allen Bill Pond to Bragg Creek section is most important for easier canoeing Downstream of Bragg Creek, the river is dangerous for novice paddlers, less interesting to skilled paddlers, not very accessible, and less heavily used. The river has high natural values below Twin Bridges.

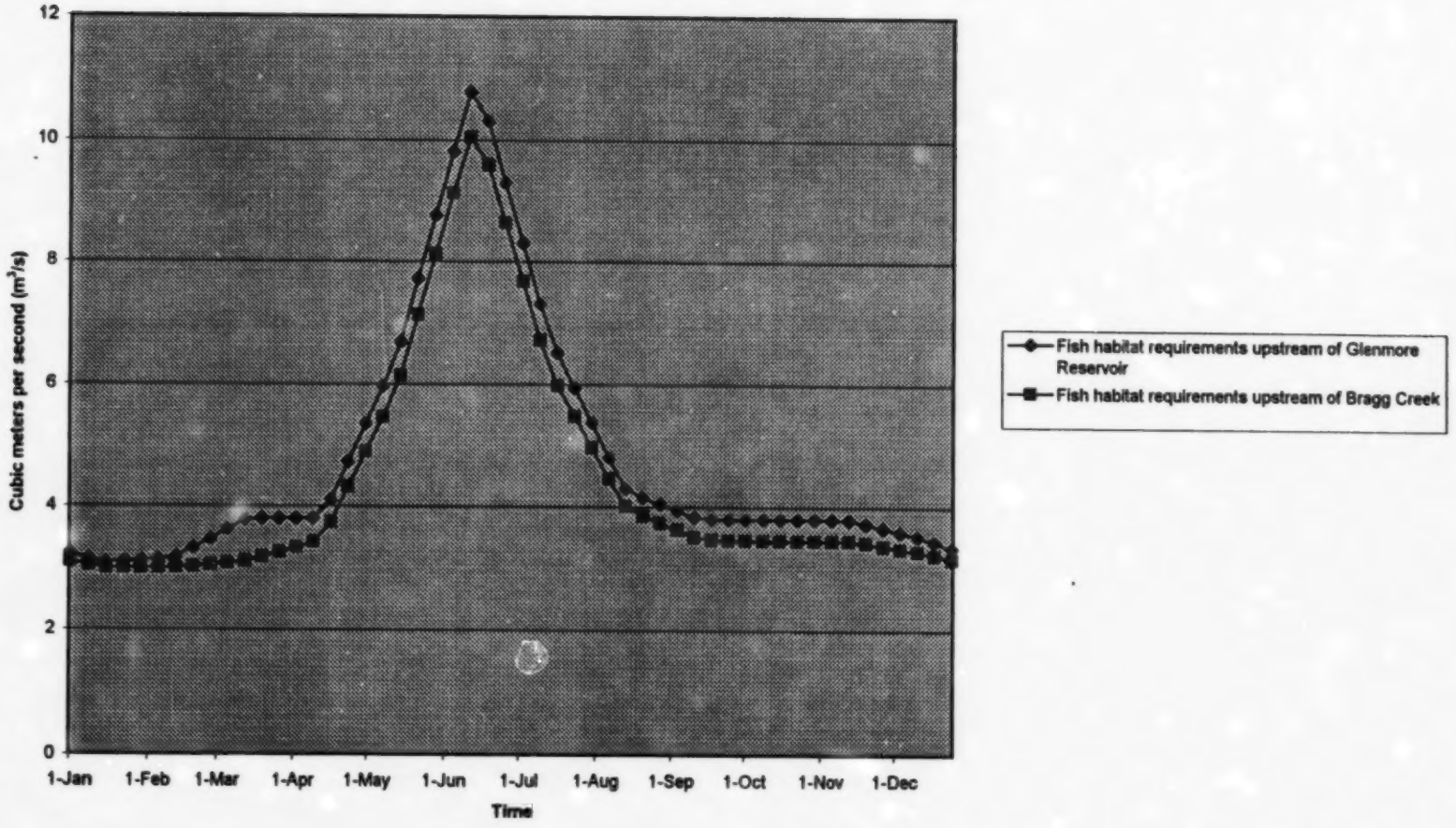
Estimates of the flow required for canoeing were developed in consultation with the Bow Waters Canoe Club. Club records were reviewed. Information on conditions for canoeing was available for 42 trips on the upper Elbow River. This information was assembled by Alberta Environment and a preliminary assessment of canoeing conditions was prepared. Al Taylor of the Canoe Club reviewed the preliminary assessment. Mr. Taylor is a long time representative of the Calgary paddling community and very knowledgeable about the Elbow River. He provided additional information and insights into conditions on the upper Elbow (and also made a presentation to the Working Group). Based on the information provided by Mr. Taylor, Alberta Environment revised the assessment of canoeing conditions and produced the following estimates of minimum and preferred flows for canoeing:

- Minimum flow for canoeing
  - upstream of Bragg Creek: 6 cubic meters per second (m^3/s)
  - downstream of Bragg Creek: 8 m^3/s

[4] Work beginning in the summer of 1999 will provide better information on the flow needed for river recreation.

Flow Required to Protect Fish Habitat
Tennant-Tessman Method
Elbow River

Figure F-3



Preferred flow for canoeing

- intermediate canoeists 15 m^3/s
- very skilled canoeists 35 m^3/s

The minimum flow estimate for canoeing is the minimum amount of water needed for a canoe to navigate the river. Flows above 45 m^3/s are too dangerous for most paddlers. The upper Elbow River is not considered suitable for novice canoeists and, as a result, no flow requirements were developed for that class of canoeing.

Ecosystem Protection

The flow requirements for fish habitat were considered to be an appropriate indicator of ecosystem health.

Downstream Uses

Numerical objectives could not be developed for downstream licences, since withdrawal demands vary substantially from year to year. The priorities provided in the *Water Act* should be sufficient to protect downstream water users.

In developing instream objectives for the lower Elbow River (downstream of Glenmore Dam), it will be necessary to consider how objectives for the lower river might affect the flow needed in the upper river.

Probability of Meeting Instream Needs

The probability of meeting instream needs under natural conditions is shown in Figures F-4 and F-5.

From April through October under natural conditions, there is a relatively high probability (usually greater than 80%) that flow will be satisfactory for fish habitat. The probability of satisfactory flow for fish habitat drops to 30% to 60% during most of the winter.

The probability of satisfactory flows for canoeing is generally low under natural conditions. There is, at best, a 30% probability that for a sustained period of time the flow will reach the level preferred by very skilled canoeists. The opportunities for canoeists with intermediate skill are better, but the probability of preferred flows for intermediate canoeists reaches 80% only for short periods of the year. The probability of minimum flows for canoeing exceeds 80% for about half the canoeing season under natural conditions.

Figure F-4

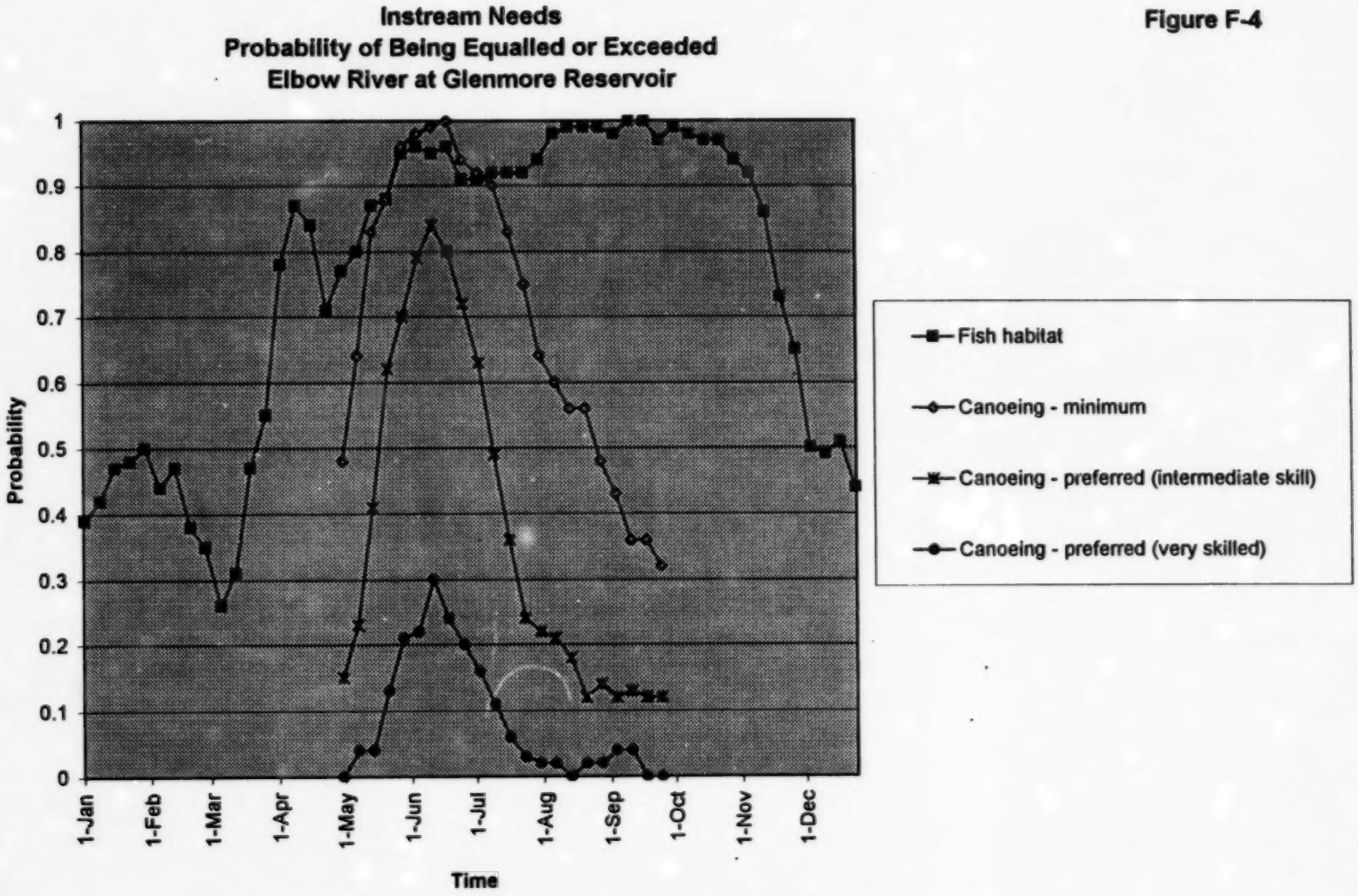
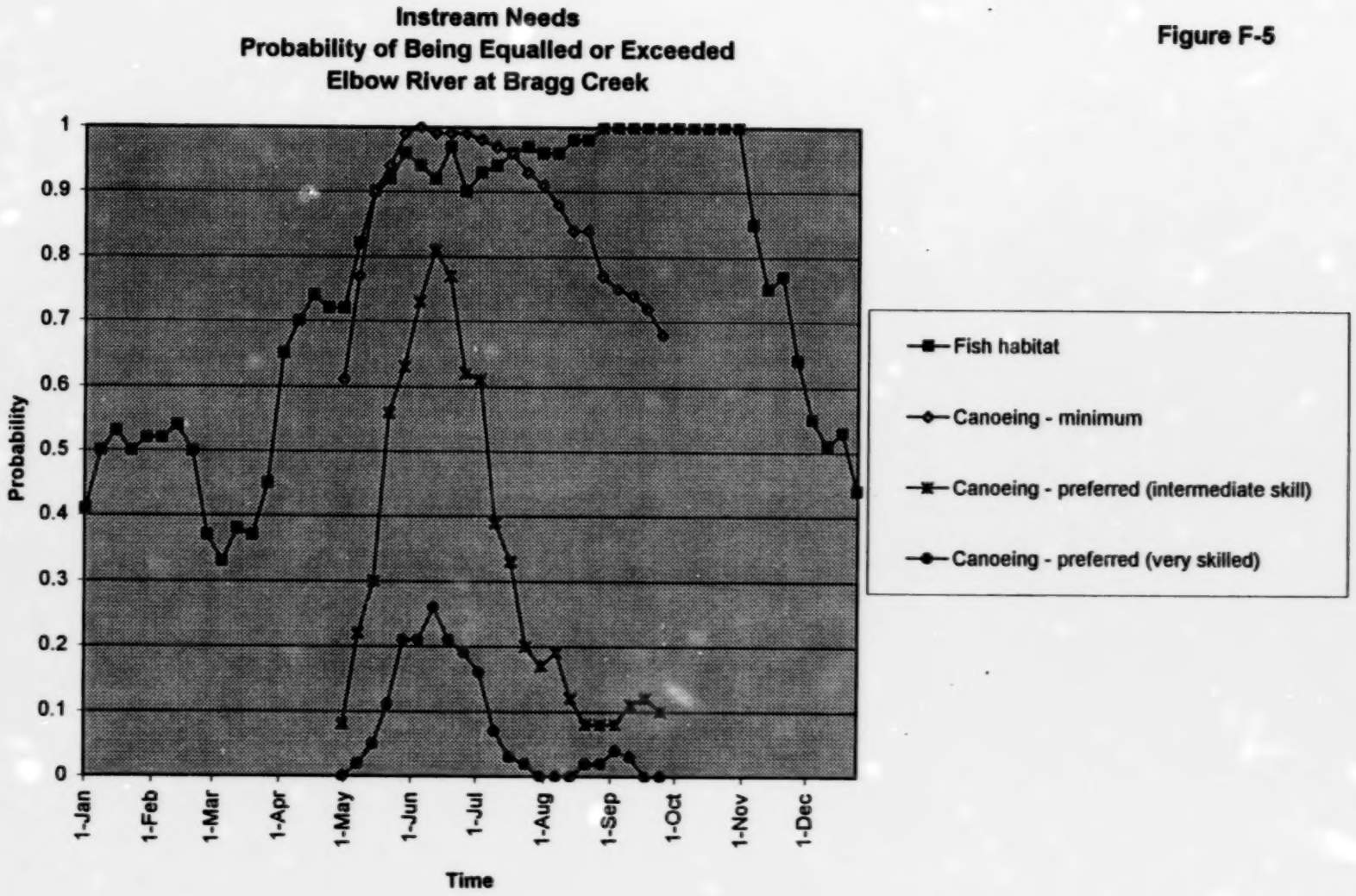

Instream Needs
Probability of Being Equalled or Exceeded
Elbow River at Glenmore Reservoir
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Time
Fish habitat
Canoeing - minimum
Canoeing - preferred (intermediate skill)
Canoeing - preferred (very skilled)

Figure F-5


Instream Needs
Probability of Being Equalled or Exceeded
Elbow River at Bragg Creek
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Time
Fish habitat
Canoeing - minimum
Canoeing - preferred (intermediate skill)
Canoeing - preferred (very skilled)

Appendix G

Water Quantity Objectives

Upper Elbow River
Instream Objectives
Working Group

WATER QUANTITY OBJECTIVES

Introduction

These objectives were developed by the Upper Elbow River Instream Objectives Working Group.

The quantity of water flowing in the Elbow River is important to those who want to withdraw water and those who want the water to remain in the river for their use (e.g., for recreation or aesthetic value) or to maintain the quality of the aquatic and riparian[1] ecosystem.

The flow of water can be affected by a number of factors such as

- the type of land the river flows through
- the uses of the land
- the time of year
- the amount and intensity of precipitation
- the recharge of ground water from surface water and the discharge of ground water to the river and its tributaries
- the amount of water withdrawn from water bodies and ground water aquifers.

Water Quantity Objectives for the Upper Elbow River

General Objective

- Use best management practices for the management of land (in particular riparian habitat) and water withdrawals

Existing Water Rights

- Ensure that there is sufficient flow to meet domestic use and the requirements of existing licences

Water Use	Numerical Objectives
Existing water rights	City of Calgary demand plus diversion rates for other downstream, mainstem licences

[1] Riparian means adjacent to a water body.

Recreation and Aesthetic Enjoyment

- Maintain river recreation opportunities

Water Use	Numerical Objectives
Recreation	Flow requirements for canoeing

Ecosystem

- Ensure that flows are sufficient to maintain a high quality aquatic and riparian ecosystem

Water Use	Numerical Objectives
Fisheries	Tennant-Tessman (40% of average flow)

It is recommended that the Tennant-Tessman objectives be interim until such time as a fisheries inventory is completed

Agriculture

- Water quantity throughout the basin should be adequate to meet licensed and traditional agriculture uses.[2]

- Maintain flow in the Elbow River and its tributaries that is sufficient to support the watering of livestock in accordance with good agricultural practices and traditional densities.

Future Use

- Ensure that water allocation and transfer provide opportunities for growth and development while respecting existing water rights and protecting domestic and instream uses

Numerical Objectives

Fish Habitat, Aquatic Ecosystem, and Downstream Users

Working Group members felt that the instream objectives should provide protection for fish habitat and downstream water uses. Protecting the aquatic ecosystem and meeting the needs of existing users were considered to be essential goals to meet. The Tennant-Tessman flow requirements for fish habitat were accepted until better information becomes available.

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[2] Under the *Water Act*, traditional agriculture uses are raising animals or applying pesticides to crops, as part of a farm unit. To qualify as a traditional agriculture use, the use of water must have begun before the *Water Act* came into force (January 1, 1999). The maximum amount of water that can be used from a diversion point is approximately 5 acre feet/year.

River Recreation

There was wide-ranging discussion on whether to use the requirements for canoeing as instream objectives.

Alberta Environment supports the consideration of recreation requirements just as it does for fisheries or other instream needs. It feels that within Kananaskis Country a high value should be given to maintaining river flows in support of river recreation activities. The Elbow River from the confluence with the Little Elbow River (especially from Canyon Creek down to Allen Bill Pond and Bragg Creek) is an important paddling stream. The upper Elbow is an easily accessible, high quality, natural, and scenic river. The Elbow River along with the Sheep River, Highwood River, and, to a lesser extent, the Ghost River and Waiparous Creek represent the best wild rivers in the Calgary area. The maintenance of natural flow variability between seasons and from one year to the next is crucial to maintaining the excellent wild river paddling opportunities on the upper Elbow.

Some members of the Working Group suggested that recreational uses are not as important as withdrawal uses such as drinking water and agriculture. Some members expressed doubts that a person would be denied the right to withdraw water in the interests of protecting flow for paddling.

Without disagreeing about the importance of withdrawal uses, other members of the Working Group suggested that a basic level of flow to support river recreation should be provided when water is available during the prime recreational period.

Within Kananaskis Country, there are only five existing water licences above Bragg Creek and these licences are for small volumes of water. The likelihood of additional substantial future demand for water withdrawal above Bragg Creek is low.

Some members of the Working Group felt that the navigational hazards downstream of Highway 22 are an important consideration. The M.D. of Rocky View does not support the use of canoeing requirements in the instream objectives because of potential liability.

It was pointed out that maintaining outdoor recreation opportunities is an economic issue since outdoor recreation is one of the factors that attracts people to the City. It was stated that, as more subdivisions go in downstream of Bragg Creek, there will be better access and greater demand for river recreation. There were differing views on whether greater use of the river for recreation would include canoeing and other paddling sports because of the danger involved.

It was noted that instream objectives are not hard and fast rules, but instead are factors that must be considered.

A variety of options for river recreation were considered including:

- Not using the canoeing requirements.

- Using the minimum flow for canoeing as an objective during July and August for all or part of the river.

- Using the preferred flow for very skilled canoeists as an objective for the river upstream of Bragg Creek / Highway 22.

- Using the preferred flow for intermediate canoeists as an objective downstream of Bragg Creek

- Using the preferred flows for canoeing as objectives for all reaches of the upper Elbow

Given that instream objectives are to be considered in decision-making, it was agreed that the following river recreation requirements should be included in the instream objectives:

1. In Kananaskis Country and downstream to Bragg Creek
   - preferred flow for very skilled canoeists
2. Bragg Creek to Highway 22
   - preferred flow for intermediate canoeists
3. Highway 22 to Glenmore Reservoir
   - minimum flow for canoeing

Appendix H

Additional Issues Raised

Upper Elbow Instream Objectives Working Group

ADDITIONAL ISSUES RAISED

During Working Group discussions, a number of issues were raised that were outside the terms of reference or could not be assessed due to lack of information.

Many of these issues are directly related to the question of maintaining adequate flow and quality in the river. They are primarily issues of how to use or implement the instream objectives. The Bow River Basin Water Council will deal with implementation of the instream objectives once it has received the report of the Working Group.

The Working Group feels it is very important that these additional issues be considered when implementation of the instream objectives is discussed.

Other Instream Needs

1. Instream needs for fishing (the activity), swimming (flow), kayaking, floating, and bird habitat

Research and Monitoring

2. Instream objectives are difficult and expensive to monitor.
3. Identification and resolution of "hot spots"
4. Impact of private septic systems on the aquatic environment.
5. Impact of recreational vehicles, logging, grazing, and roads, particularly in Kananaskis Country
6. Risks from the transportation of dangerous goods
7. Separation of naturally occurring water quality issues (e.g., natural erosion, wildlife including waterfowl) vs. man-made contaminants
8. Impact of stormwater and the effectiveness of control measures
9. Modification of the streambed and riparian habitat
10. Floodplain development and protection as it relates to the potential for increased downstream flooding
11. Fish tissue sampling as a monitoring tool
12. The lag time for ground water effects on surface water

13. The impact of fertilizer and pesticide use

14. Continued monitoring / improved monitoring

15. Impact of chlorine by-products

16. Alternatives to using chlorine as a disinfectant

17. Release of monitoring results related to logging

Education

18. Dissemination of accurate and timely information is essential to making instream objectives work.

19. It will be very difficult for water users to know if they are in danger of violating a flow or water quality objective. A system (e.g., a bulletin or newsletter) is needed to
    - give water users warning when the river is approaching critical conditions
    - inform them of how they are expected to respond to avoid violating instream objectives.

Policies

General Policies

20. The multi-purpose policy in Kananaskis Country

21. Government assistance to resolve impacts of grazing

Growth

22. Greater pressure on prime agricultural land due to urban expansion.

23. Potential for extension of sewer and water services from the City of Calgary

24. Future population projections

Operations

25. Information on when and where the Tsuu T'ina sewage lagoon discharges

Regulatory

26. Which authority will enforce instream objectives and how will it be done?

27. Ability of municipalities to regulate activities

Definitions

28. Definition of best management practices

Consistency

29. Consistency with objectives for other rivers